Newport Research Facility

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NO. 57

Report for the year ended 31st December 2012

This report follows in sequence from
the Annual Reports of the Salmon Research Agency of
Ireland Inc. and the Salmon Research Trust of Ireland Inc.

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Summary

1. The Salmon Research Agency of Ireland merged with the Marine Institute on the 1st July 1999 into Aquaculture & Catchment Management Services and in 2010 the group merged with Fisheries Ecosystem Advisory Services. This report provides a continuation of the data records for the Burrishoole facilities.

2. The total rainfall recorded in Furnace in 2012 was 1676.4 mm. Months of relatively high rainfall in 2012 were January, February, June, September and December. Low rainfall was recorded in March, April and May.

3. The environmental programme was maintained in the catchment with the network of rain gauges, water level reorders and river and lake monitoring stations all in operation.

4. The total release of micro-tagged salmon smolts of Burrishoole reared origin into L. Furnace amounted to 41,446. Smolts were released as six core and one SLICE treated group, ranging in mean weight from 63g to 79g. Smolts were released into Furnace on 26th April 2012.

5. Testing of wild salmon kelts (n=98) proved negative for IPNV and *Anasakis* were present in 88% of the fish examined.

6. In 2007, the Irish Government introduced a cessation of drift netting for salmon at sea and this was continued in 2012.

7. A total of 671 wild grilse and 6 previously spawned grilse (psg) were recorded moving upstream through the permanent traps during the season. The number of spring fish recorded was 18. The total run of wild grilse, including the Furnace rod catch (0), was 671 + 6 previously spawned grilse.

8. Returning adults were checked for net mark damage; 1.9% (n=473) of wild grilse (in June, July and predominantly in August) and 1.8% (n=1369) of reared grilse (in June, July, August and September) had net marks present.

9. The maximum spawning escapement was 668 wild and 28 reared fish.

10. A total of 7717 wild salmon smolts were recorded in the downstream trap in 2012. The wild return of 2011 smolts as wild grilse in 2012 was 10.5%. The ova to smolt survival at 0.57 – 0.65%.

11. Wild kelt survival was 54.7% and kelt return as previously spawned grilse later in the year was 3.6%.

12. The return to fresh water of the Burrishoole reared grilse recorded was 4.89%, increased from 2.7% recorded in 2011.

13. A total of 139 wild sea trout and a further 47 non-silvered trout migrated upstream through the traps in 2012. Of the sea trout, 35 were adults and 104 (74.8%) were finnock.

14. The 2012 sea trout smolt run amounted to 632 smolts.

15. The percentage of smolts returning as finnock in the same year has historically ranged from 11.4% to 32.4%. In 1989 it collapsed to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's between 4 & 10%, rising to 16.7% in 1999. Finnock return in 2012 was 16.9%.

16. Silver eel trapping continued with the total run amounting to 3335 with the run mainly in September, October and November. After that, the run dropped off and few eels were recorded in December or in early 2013.

17. A total of 128 salmon were caught in the Rod Fishery in 2012. The catch consisted of 50 wild fish and 78 reared salmon. All wild fish were returned alive. There were 10 sea trout reported caught on L. Furnace and five on L. Feeagh and these were returned alive. 788 brown trout were also reported caught on L. Feeagh in 2012.

18. 2012 marked the completion of 22 years of catchment electrofishing surveys for juvenile salmonids and eel.

19. Eel fyke net surveys of Bunaveela, Feeagh and Furnace were undertaken in 2012. The data from these surveys were included in the National eel database.

20. *Anguillicoloides crassus*, the non-native swimbladder parasite of eel, was recorded in the saline waters of Lough Furnace for the first time in 2011 and again in 2012. It has not been observed to date in freshwater in Burrishoole. This is the first known introduction of an invasive species into Burrishoole.

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1 Introduction

The Salmon Research Agency merged with the national Marine Institute on the 1st July 1999. The staff of the Agency was absorbed into the Aquaculture and Catchment Services Group of the Institute and the research facilities at Furnace have undergone a programme of upgrade and improvement. The core monitoring work of the Agency will continue but its unique experimental facilities, both in relation to aquaculture and wild fisheries, will be fully utilised within the context of the Marine Institutes published Research, Technology, Development and Innovation Strategy. The merger has resulted in an increased national role for the work of the Agency and a consolidation of the trap and laboratory facilities at Newport. In 2010, the fisheries and catchment team based in Newport was integrated into the Fisheries Ecosystem Advisory Services Group (FEAS) of the Marine Institute.

This report represents a continuation of the Annual Reports published by the Salmon Research Agency of Ireland. The data presented creates a unique record of fish rearing and wild fish census data for the past 42 years. This data is an essential component in the local, regional and national management of salmon, sea trout and eel and is becoming ever more valuable in the light of increasing pressures on natural stocks, such as exploitation, habitat degradation and global climate change scenarios. The fish monitoring facilities in Newport, along with the reared and ranched salmon stocks held in Burrishoole, are also essential for the evaluation of novel enhancement techniques, alternative stocks and ranching and evaluation of interactions between farmed, ranched and wild strains.

2 Environmental Data

2.1 Mill Race Data

2.1.1 Rainfall

Daily meteorological data were collected during 2012 at the manual Met Station in Furnace. The monthly rainfall figures for 2009, 2010, 2011 and 2012 are given in Table 2.1, along with the annual totals for the years 1977 to 2012. Months of relatively high rainfall in 2012 were January, February, June, September and December. Low rainfall was recorded in March, April and May. The total rainfall was 1676.4mm in 2012. Daily rainfall amounts are shown in Figure 2.1.

Table 2-1: Monthly rainfall totals (mm) for the Furnace Station in 2009, 2010, 2011 and 2012 and the annual totals for 1977 to 2012.

Month	2009	2010	2011	2012	Year	Total	Year	Total
January	143.8	86.0	93.4	186.0	1977	1579.7	2000	1833.2
February	61.8	69.1	192.7	169.0	1978	1592.2	2001	1298.7
March	124.9	82.5	82.6	70.7	1979	1653.3	2002	1715.9
April	92.8	48.8	89.2	92.9	1980	1792.1	2003	1353.2
May	128.8	48.2	161.1	78.0	1981	1646.8	2004	1641.3
June	67.5	44.3	96.1	178.7	1982	1609.6	2005	1608.2
July	243.8	129.3	40.5	111.1	1983	1495.9	2006	1550.7
August	254.7	100.2	135.1	113.1	1984	1556.6	2007	1576.8
September	87.1	262.4	199.1	196.0	1985	1584.1	2008	1805.0
October	132.3	130.9	276.7	118.4	1986	1886.9	2009	1793.9
November	322.6	240.1	167.0	175.3	1987	1373.6	2010	1311.6
December	133.8	69.8	293.4	187.2	1988	1715.2	2011	1826.9
					1989	1583.9	2012	1676.4
Total	1793.9	1311.6	1826.9	1676.4	1993	1473.4		
					1994	1757.1		
					1995	1382.5		
					1996	1286.6		
					1997	1351.6		
					1998	1830.9		
					1999	1949.1		

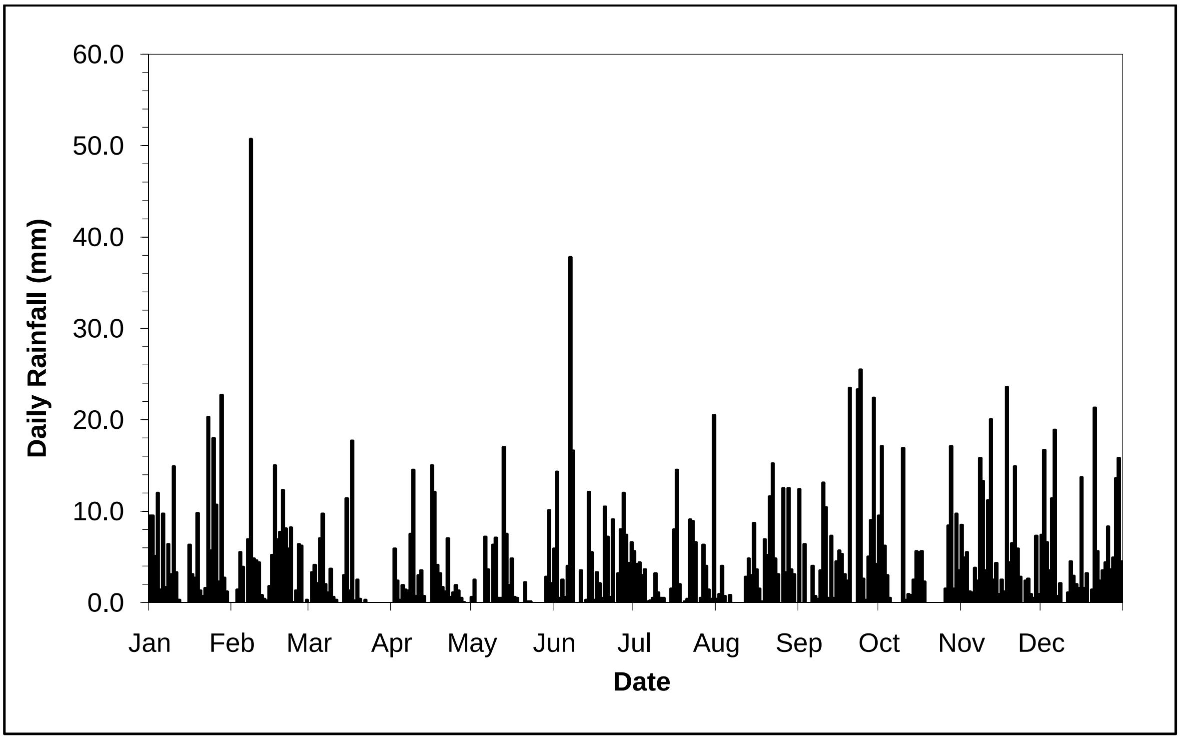


Figure 2-1: Daily rainfall amounts (mm) recorded in the Mill Race manual weather station.

2.1.2 Water Level and Temperature

Water Level: Difficulties were experienced in 2003 with the automatic water level chart recorder which had been in place since before 1970. An OTT Orphimedes automatic water level recorder was installed in late January 2004 and data from this sensor are presented here. Water levels are recorded every 15 minutes and are presented in Figure 2.2 recorded at 00:00 hrs. This approximates to the mid-night readings from the old chart recorder.

The plot in Figure 2.2 shows two short drought periods in March and May and also shows the period the Mill Race channel was closed from 16th May to the 17 July. There was a dam breach during a flood in June.

Water Temperature: In 2004, a TidbiT temperature logger was installed along with the chart recorder and this records water temperature every 30 minutes. The temperature logger data are presented in Figure 2.3, recorded at the closest time to midnight (<30mins).

In 2012, water temperatures (recorded at midnight) fell to a minimum of 4.4^{0}C on the 2nd February. There was a fairly steady increase in temperature from then, with a short warm period at the end of March, until the end of May. There was a sharp increase to a peak of 15.4^{0}C on the 1st June but the temperature dropped back to 10.9^{0}C on the 1st June. There were two small increases to 14.4 and 14.6^{0}C in July followed by a further increase to a maximum of 15.7^{0}C on the 8th August, a full four degrees lower than in 2009 and one degree lower than in 2010 but similar to 2011. The temperature dropped fairly steadily from the middle of August for the rest of the year to a minimum of 3.6^{0}C on the 14th of December.

Note that for the period on the 16th May to the 18th December, the TidbiT was relocated to the staff gauge at the south end of L. Feeagh, adjacent to the Mill Race. This was because the Mill race was dried for maintenance works on the traps from the 16th May to the 17th July.

The mean annual midnight water temperature in 2012 was the lowest on record since 1960 (Fig. 2.4).

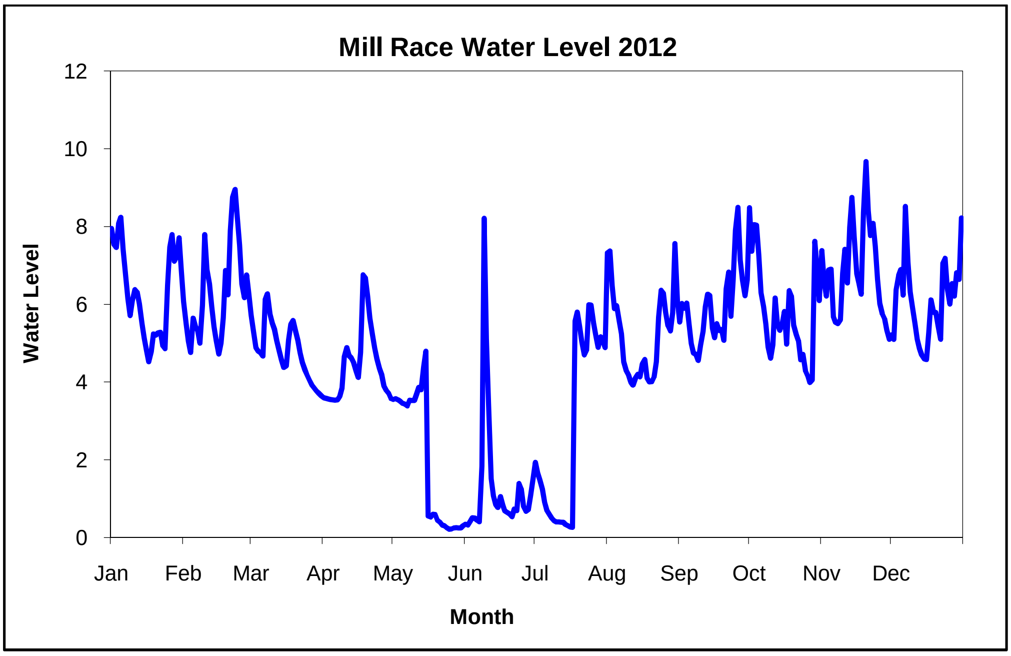


Figure 2-2: Water levels recorded at mid-night for the Mill Race using an OTT Orphimedes automatic water level recorder. Note the Mill Race was closed from 15th May to 18th July with a breach in the dam on 9th June

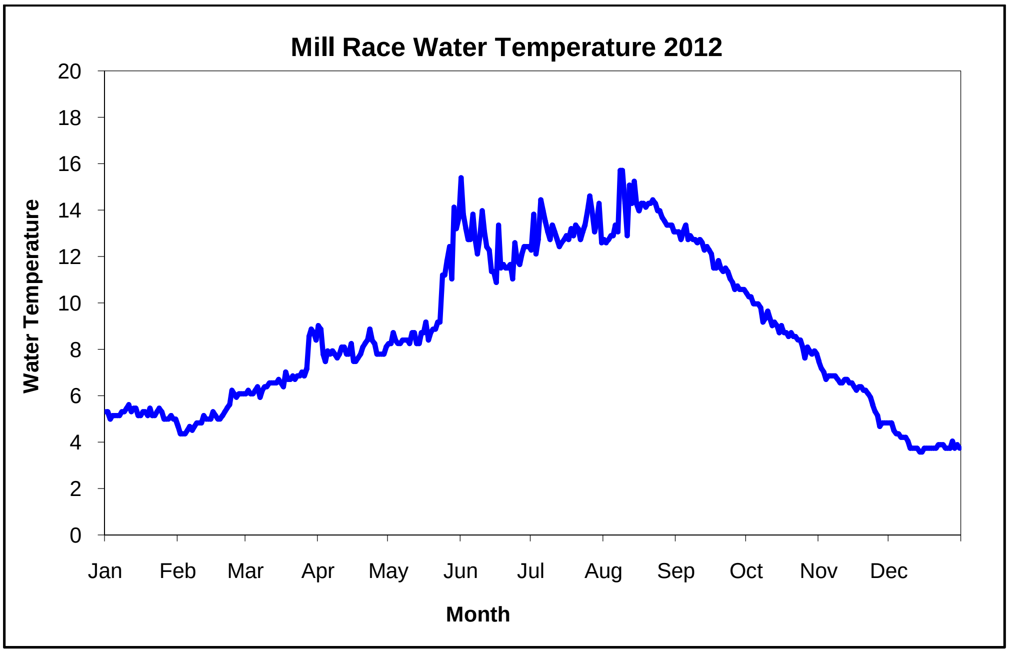


Figure 2-3: Water temperatures (°C) recorded, by TidbiT data logger, at mid-night for the Mill Race. Note the TidbiT was relocated to the Lough Feeagh staff gauge from 15th May to the 18th December.

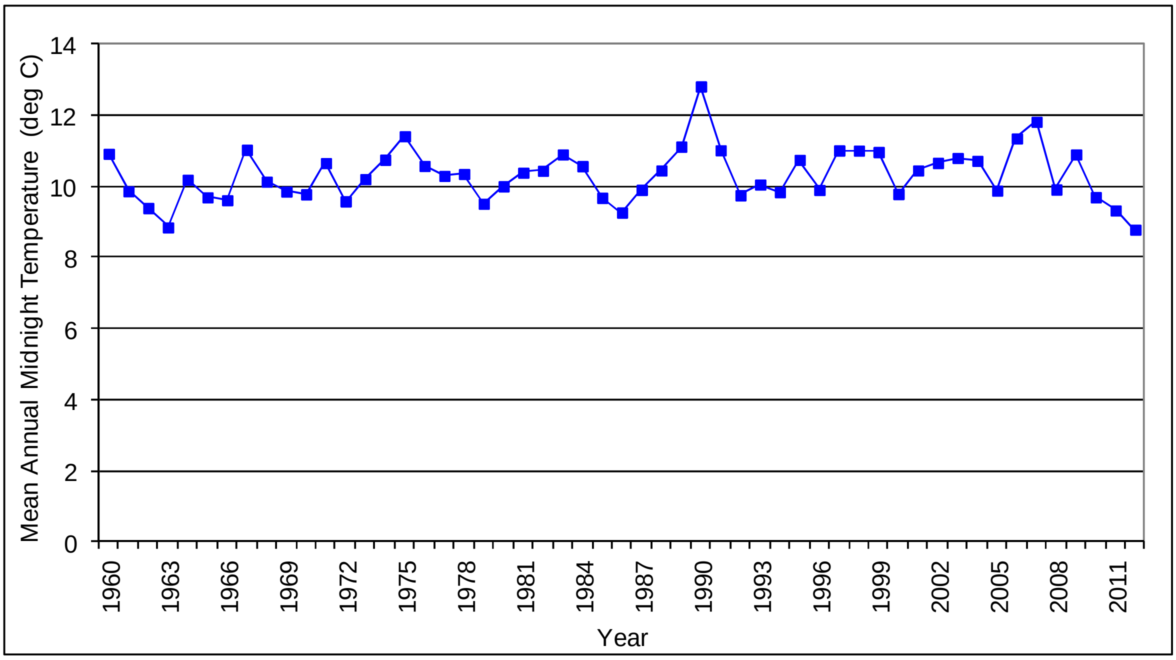


Figure 2-4: Mean annual midnight temperatures for the Mill Race.

2.2 Catchment Programme

2.2.1 Background

In recent years, the combined effect of extreme weather events with impacts of land use, have had a significant effect on the erosion rates recorded in many upland areas. Since 1995 the Marine Institute has operated a series of automatic monitoring stations to monitor these impacts, the influence of weather patterns and to attempt to quantify the transport of suspended sediments in the Burrishoole catchment. These automatic stations, funded under EU LIFE and National programmes, include two lake stations (AWQMS – installed under EU LIFE 93 and ERDF 2008), which have various meteorological instruments included with a suite of underwater temperature and water chemistry sensors, and three river stations, (ARMS – installed under EU LIFE 98), which are equipped with sensors for measuring water temperature, water level, pH, conductivity, dissolved oxygen, and turbidity. The automatic monitoring stations are also equipped with a telemetry system for relaying high-resolution data back to the laboratory.

In addition, the Institute has also deployed additional core-funded instrumentation in the catchment including temperature loggers, 11 water level recorders and 15 data-logging rain gauges in the Burrishoole catchment, two in the Owengarve catchment and two in the Owenduff catchment, which will build up a detailed profile of precipitation in a mountainous catchment.

Water levels within the catchment are measured using a series of OTT Orpheus mini's water level recorders which measure water level at fifteen-minute intervals. These data can be used to calculate water volumes on an hourly or daily basis. An important feature of the monitoring network is the ability to simultaneously collect data from river, lake, and climatic instruments. The continuing integration of this data with ongoing fish population surveys is an important component of the research programme.

In 2007, the Burrishoole catchment became a member of the Global Lake Ecological Observatory Network (GLEON: http://www.gleon.org), an association of limnologists, information technology experts and engineers whose goal is to establish a persistent network of lake ecology observatories (http://www.gleon.org). Data from these observatories (of which Lough Feeagh and Lough

Furnace, both located in the Burrishoole, are included) will allow a better understanding of key processes, such as the effects of climate and land use on lake function, episodic events and carbon cycling within lakes. The research involvement in GLEON is a continuation of the work carried out under various national and internationally funded projects. In 2012 the Marine Institute co-hosted the annual GLEON meeting, GLEON14, with Dundalk Institute of Technology. The meeting was held in Mulranny Park Hotel, and was deemed a great success. The opening address was given by Dr. Peter Heffernan and in excess of 130 international Scientists and water managers attended this meeting which was a wonderful testament to the work being done by the Marine Institute in this area. The Institute hosted a field day in Burrishoole with almost 100 delegates attending the activities.

Previous research identified a scientific gap in knowledge in terms of understanding the implications of present and projected future changes in stream flow, water temperature, pH levels and DO concentrations on fish productivity in the catchment. To address this, in 2008 and 2009 a multidisciplinary team of scientists, funded within the SSTI Climate Change programme, from the National University of Ireland Maynooth (NUIM), TCD and the Marine Institute, undertook an analysis of both present and likely future climate impacts on the catchment with a view to furthering the understanding of the interlinkages between climate, climate change, and the freshwater ecosystem. This report entitled *RESCALE: Review and Simulate Climate and Catchment Responses at Burrishoole*, (Fealy *et al*. 2010) builds on the wealth of scientific endeavours previously undertaken on the catchment and represents the collaborative efforts of the multidisciplinary research team.

Fealy, R., Allott, N., Broderick, C., deEyto, E., Dillane, M., Erdil, R.M., Jennings, E. McCrann, K., Murphy, C., O'Toole, C., Poole, R., Rogan, G., Ryder, L., Taylor, D., Whelan, K. & White, J. (2010). RESCALE: Review and Simulate Climate and Ctachment Responses at Burrishoole. Marine Institute 2010; 138pp.

2.2.2 The 2012 Programme

The maintenance and development of long term physical, chemical and biological datasets characterising the freshwater component of the Burrishoole catchment continued in 2012. Regular downloads of remote equipment, as well as routine maintenance and replacement of broken equipment, were carried out at all sites. Considerable efforts were continued in 2012 to enhance the usability of the high frequency data, by development and maintenance of relevant rating curves and instrument calibration.

2.2.3 The Black River

The main river flowing into Lough Feeagh is the Black River, also known as the Shramore River. A water level recorder is installed approximately 500m above the lake. Figure 2.5 shows the average daily water level and Figure 2.6 shows the average monthly water levels from 2002 to 2012. The high rainfall event in July 2009, mentioned in Section 2.1.1 of the 2009 report, can be seen reflected in the water level in the Black River followed by the unusually dry winter/spring period in 2010.

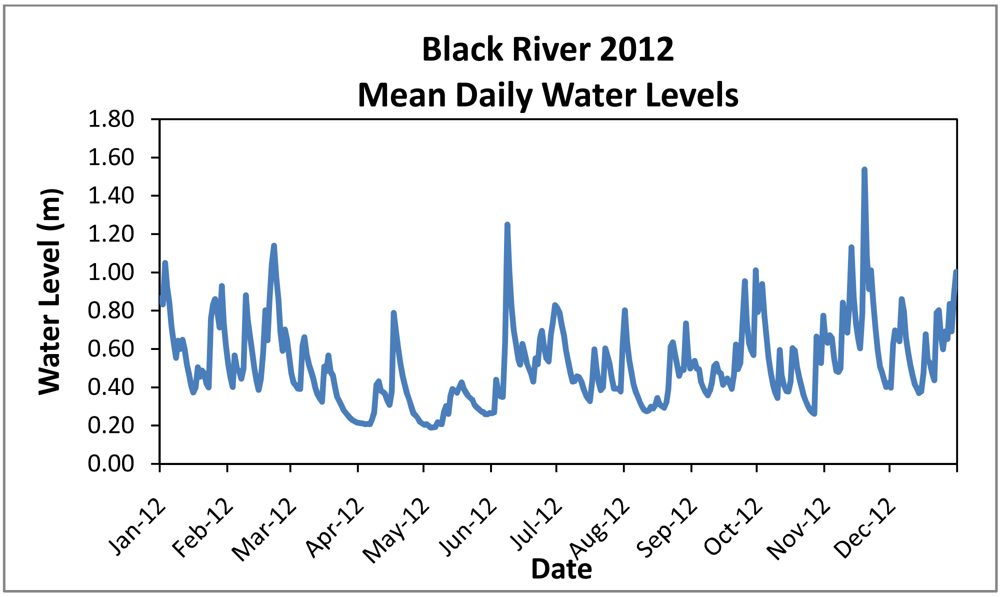


Figure 2-5: Mean daily water level for the Black River, 2012.

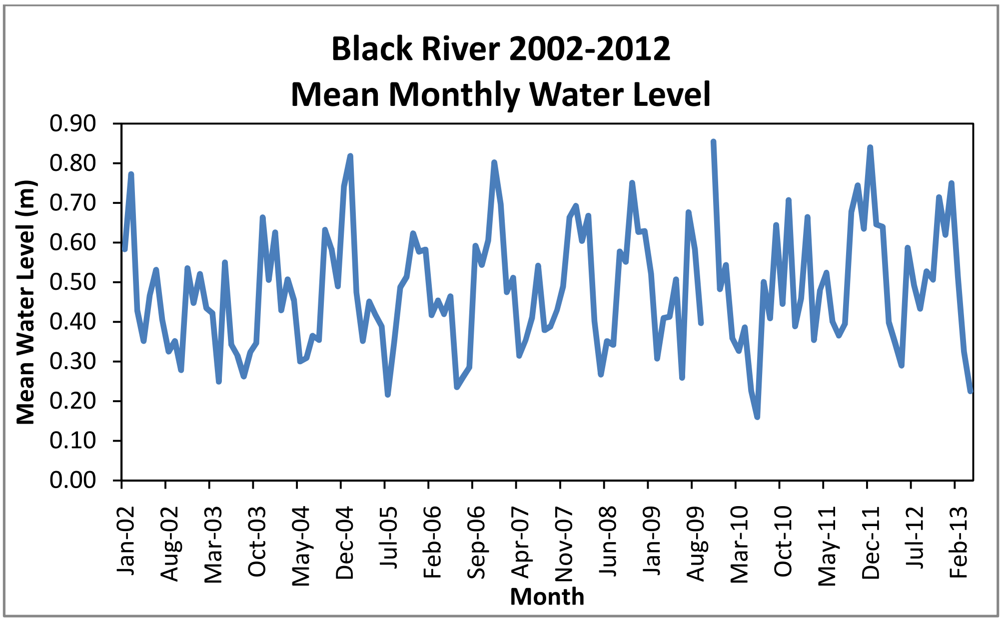


Figure 2-6: Monthly mean water levels for the Black River, 2002-2012.

2.2.4 Lough Feeagh

Lough Feeagh is situated in the Burrishoole catchment in the west of Ireland close to the Atlantic coast and is therefore strongly affected by the temperate oceanic climate that predominates in the region. The water is soft (pH range 5.7-6.9 in 2007, alkalinity 6mgl^{-1} $CaCO_3$) and highly coloured (2007 mean of 82 mgl^{-1} PtCo), and is oligotrophic, with Chlorophyll "a" ranging between 1 and 2µg l^{-1}. Mean annual Total Phosphorous is 8.6µg l^{-1} (2012) and Total Nitrogen is 0.37mgl^{-1} (2012). The Lough Feeagh Automatic Water Quality Monitoring System (AWQMS) measures various parameters using a Hydrolab datasonde 5, two Chelsea scientific minitrackas and a Seapoint fluorometer (pH, dissolved oxygen, temperature and conductivity, turbidity, Chl '*a*' fluorescence and CDOM fluorescence). These parameters are measured every two minutes and an hourly average is calculated for all the parameters. There is also a thermistor chain and various weather instruments continually monitoring parameters such as barometric pressure, wind speed and wind direction.

The Lough Feeagh AWQMS operated well in 2012, with only short time periods of missing data. After a warm winter (unlike the previous two years), the lake stratified over the summer (Fig. 2.7). The water temperature in the epilimnion was warmer than previous years, touching 18 ^{o}C in late August (Fig. 2.8). The temperature profile for 2012 was more similar to the years preceding the two cold winters over 09/10 and 10/11 (Fig. 2.8).

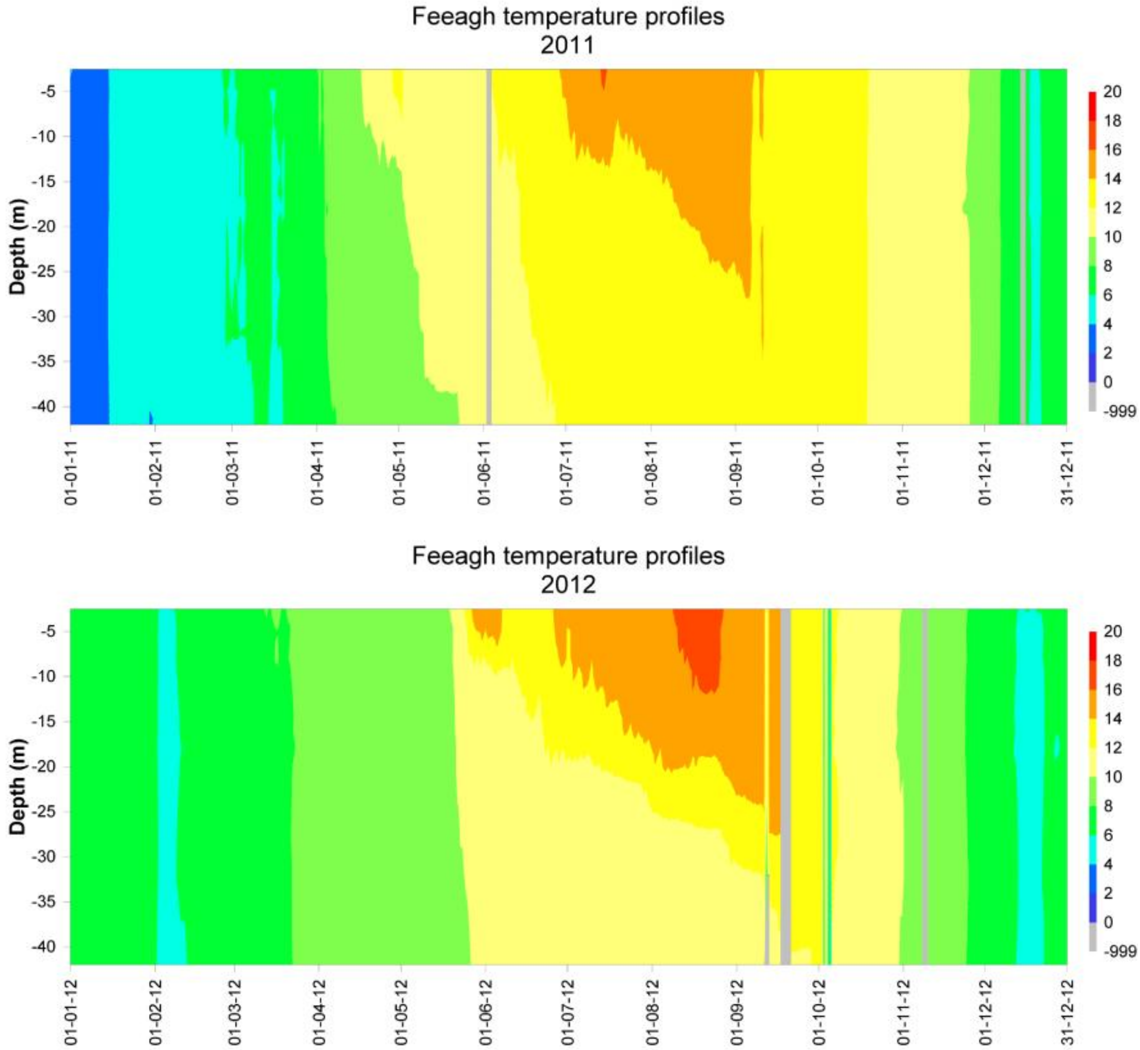


Figure 2-7: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2011 (top) and 2012 (bottom). The grey denotes missing data.

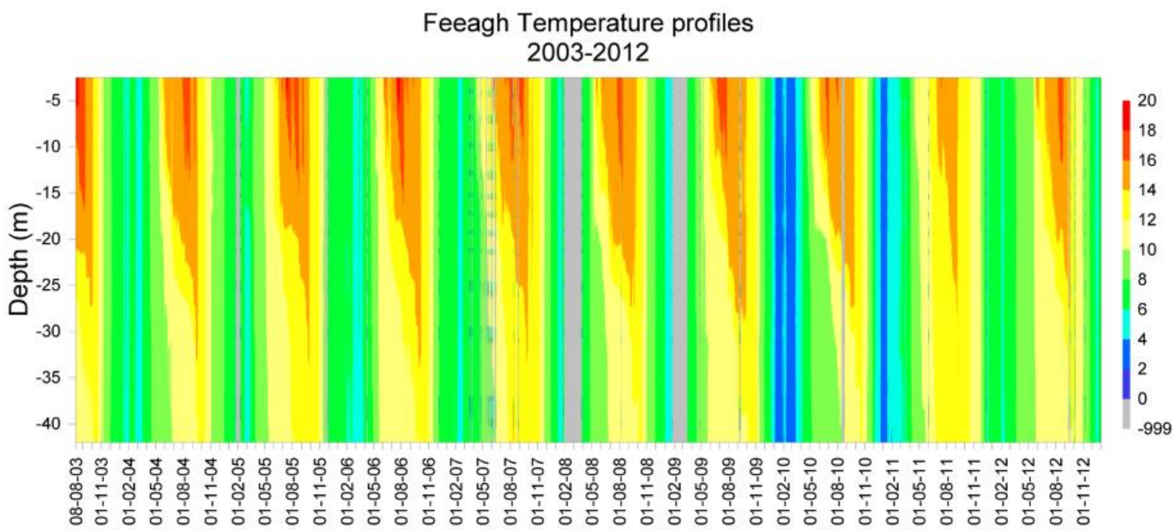


Figure 2-8: Temperature profiles for L. Feeagh measured using PRT sensors on the AWQMS for 2003-2012. The grey denotes missing data.

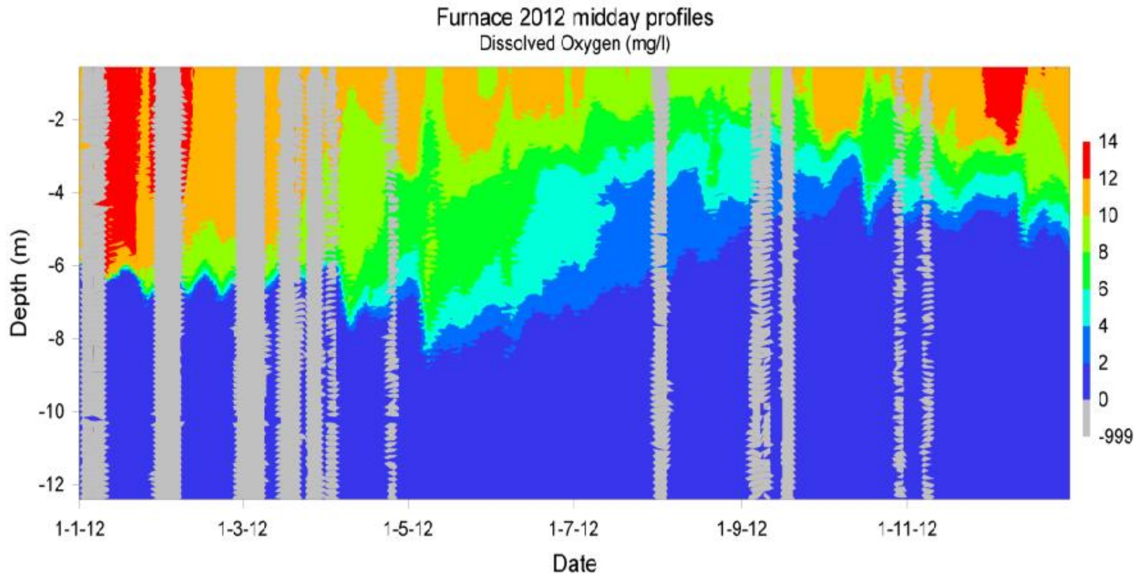
2.2.5 Lough Furnace

Lough Furnace is situated in the lower end of the Burrishoole catchment. Lough Furnace, (2km from north to south at its widest point, covering an area of 170ha, max depth is 21m with an average depth of 7m) is a cryptodepression tidal lagoon lake. Sea water enters the lake during spring tides but the freshwater exchange ensures relativity low salinities at the surface throughout the year. Initial results indicated that in 2008 the pH ranged from 7.0- 8.1 and dissolved oxygen levels decreased dramatically below 3m in the lake. The lough is thermally stratified throughout the year with spring and autumn inversions and accompanying halo- and oxyclines. Monitoring of L. Furnace commenced in the early 1970s and automatic daily monitoring commenced in May 2008. This AWQMS (Fig. 2.9) has a Datasonde DX5 attached to a profiling winch, enabling temperature, conductivity, dissolved oxygen (% and mg/l), salinity and pH profiles of the lake to be taken. The winch profiles the lake 4 times a day (6am, noon, 6pm and midnight), taking four hours to run a profile and is parked for two hours. There is also a nephelometer and fluorometer positioned one meter below the water column. All parameters are measured every two minutes and an hourly average is then calculated. A weather station is also fully functional on the AWQMS measuring wind direction, wind speed, radiation, relative humidity and barometric pressure.

Figure 2-9: The Automatic Water Quality Monitoring Station (AWQMS) on L. Furnace (left) and the meteorological instruments attached (right)

Lough Furnace exhibited a permanent halocline between 4 and 5 metres through 2012, with dissolved oxygen and temperature being significantly lower at depth (Fig. 2.10-11). Low water levels in Feeagh during April meant that the freshwater surface layer was reduced and this was only gradually restored throughout the year. No mixing between the epilimnion and hypolimnion occurred (Fig. 2.10), and the main algal productivity occurred just above the halocline during the spring and summer (Fig. 2.11).

Four years of continuous data from the AWQMS on Lough Furnace have now being collected, and show that, in general, the halocline has been stable over that time period, but the depth varies between 4 and 6 metres. Summer temperatures in 2011 and 2012 were lower than the previous years, as was algal productivity (Figs. 2.12 & 2.13).



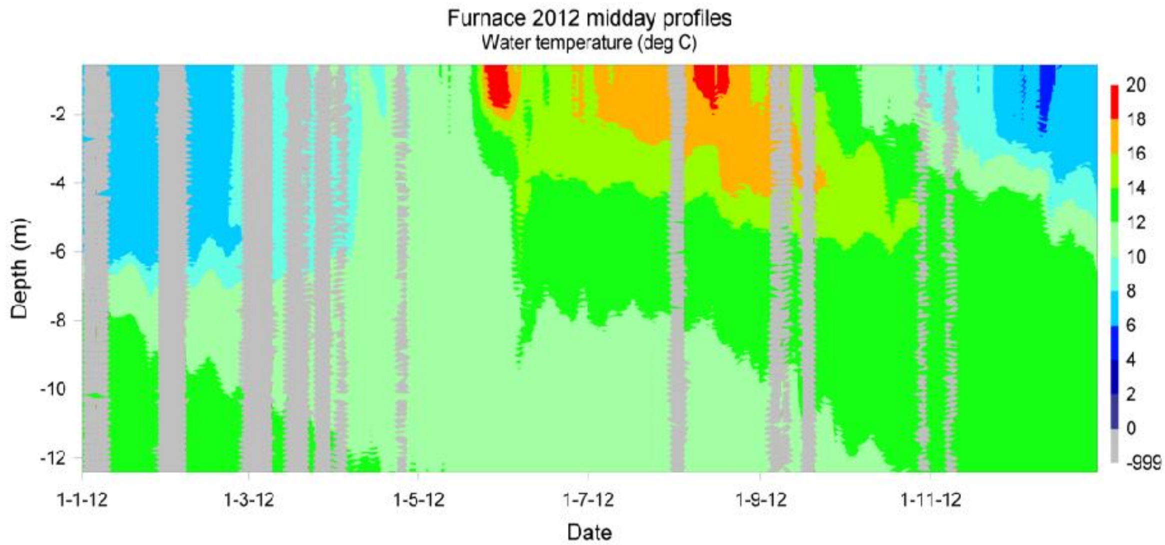


Figure 2-10: Oxygen (top) and temperature (bottom) profiles from Lough Furnace, 2012. Grey indicates missing values.

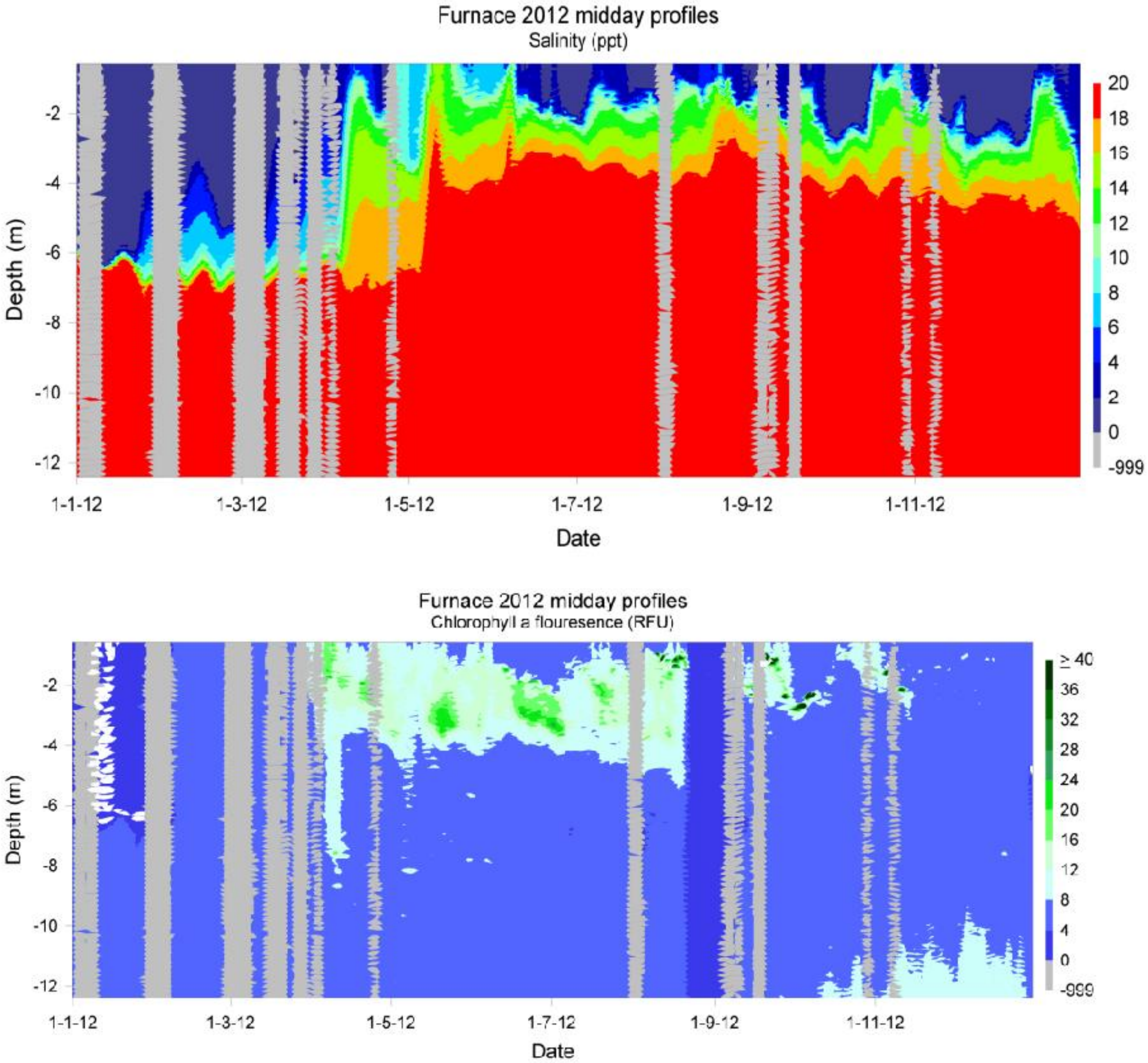


Figure 2-11: Salinity (top) and Chlorophyll *a* (bottom) profiles from Lough Furnace, 2012. Grey indicates missing values.

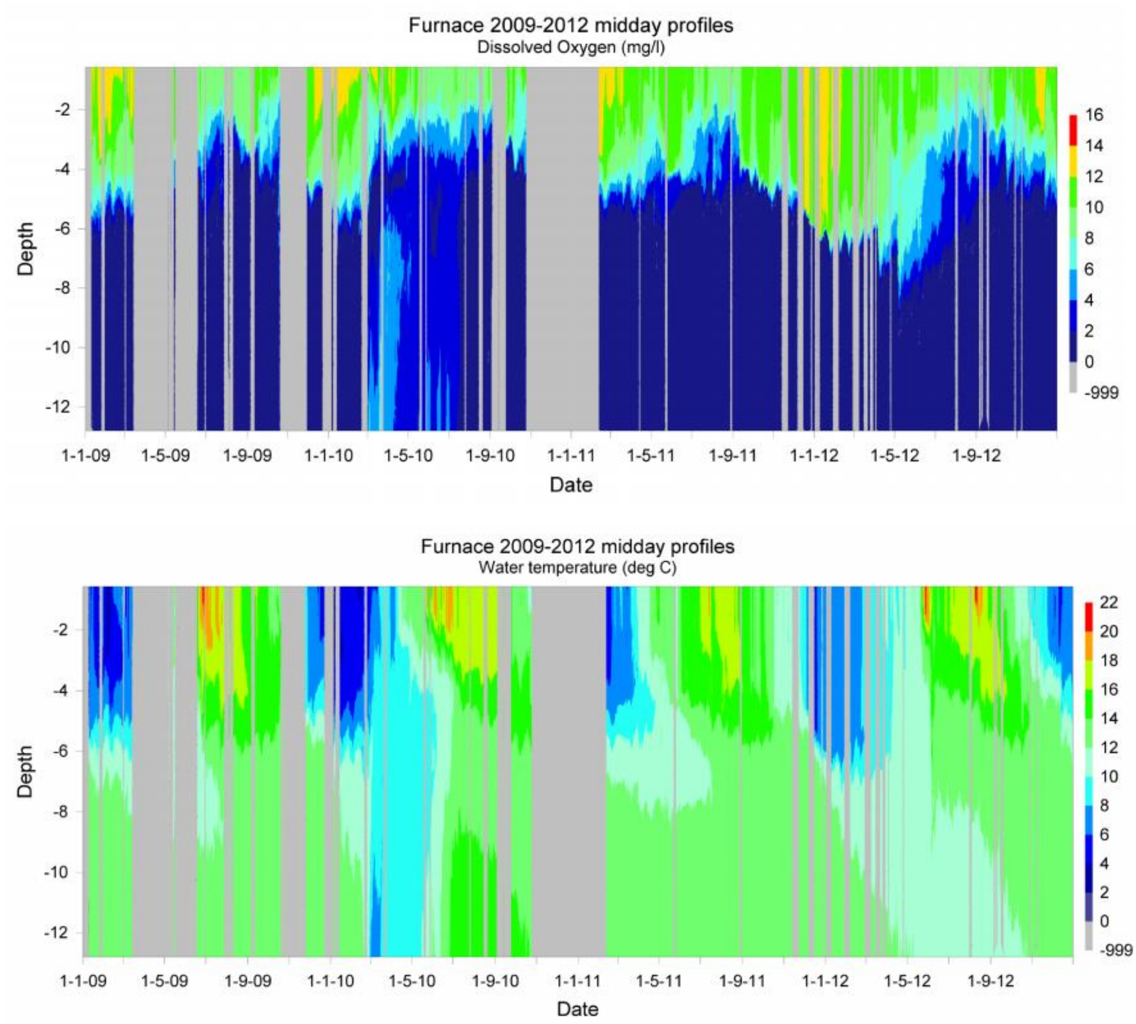


Figure 2-12: Oxygen (top) and temperature (bottom) profiles from Lough Furnace, for 2009 to 2012. Grey indicates missing values.

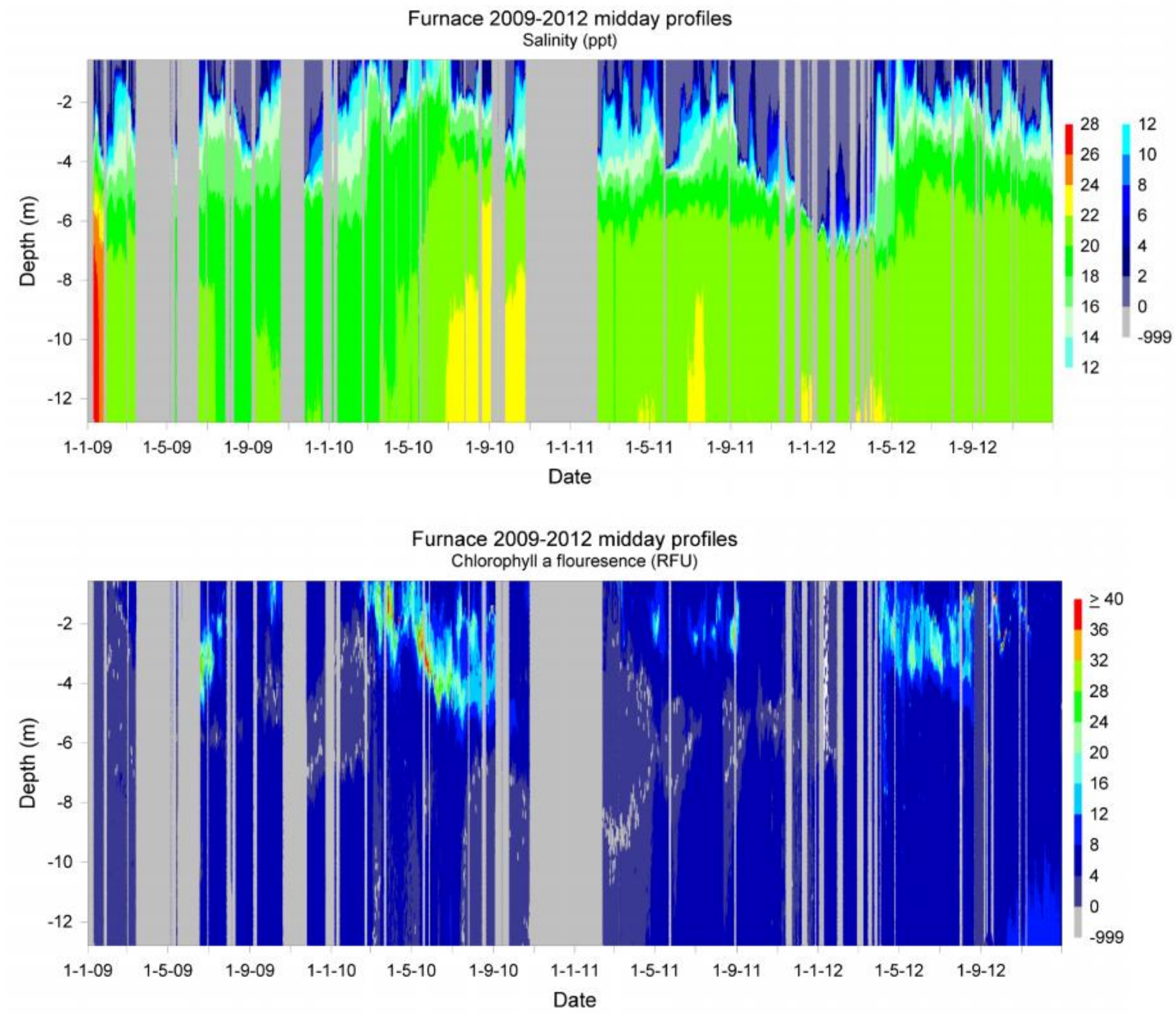


Figure 2-13: Long term Salinity (top) and Chlorophyll *a* (bottom) profiles from Lough Furnace, for 2009 to 2012. Grey indicates missing values.

3 Salmonid Rearing

3.1 Salmon Stocks 2011

3.1.1 Ranching

The total release in 2012 of microtagged smolts of ranched Burrishoole grilse origin into Lough Furnace was 41,446. Seven groups, including one group treated with 'SLICE' for protection against lice infestation during early migration, were released on 26th April 2012. Mean weights ranged from 63 to 79gm.

Tag code details are shown in Table 5.1.

3.2 Salmon Stocks 2012

Burrishoole ranch salmon, and an experimental ranch group produced from 2SW Delphi ranch parents, were hatched in 2012. There was no commercial salmon production in the Unit.

Growth and survival were good with an overall survival of 85% (groups ranging 70% - 97%) from first feeding in April to grading in August. First feeding commenced in the first group (stripped on 13th December 2011) on 30th March and in the last group (stripped on 31st January 2012) on 30th April 2012. Water temperatures were adequate for first feeding, ranging 9 to10 ^{0}C during April. Grading was carried out during August and in late October/early November, groups were mixed to produce core 'medium' and 'large' release groups. The progeny of the earliest and latest stripping dates (SRA1 and SRA8) were retained as separate groups.

Some formalin treatments were required between August and November to control parasite levels. Stocks remaining in December 2012 comprised 39,099 Burrishoole ranch and 11,509 experimental Delphi MSW salmon.

3.3 Salmon Stocks 2013 (Grilse ova laid down in 2012/'13)

An estimated 75.5% of all returns and 75.7% of ranch grilse returns were processed between March and August. Normally, when rainfall is moderate to high in July and August and consequently water levels are adequate for ranch returns to move into the traps, between 40 and 60 per cent of the total return can be expected to run from September onwards. Ranched salmon returns in 2012 were the progeny of adult returns 2009, when there was an abrupt reduction in the number of adult returns from mid-September onwards, with only six further upstream returns. Of note, salmon returns in 2012 were not only higher than expected but the proportion of the run captured in the traps by September was greater than normal. This supports the view that failure of the later component of grilse to return in 2009 and consequent breeding from the earlier stock component may have resulted in a greater proportion of early running grilse in 2012.

In 2012, the Mill Race was closed from 16th May to 18th July to facilitate refurbishment of the Mill Race traps and during this period all fish movement was via the Salmon Leap traps. Water levels were relatively high throughout this period and there was no impediment to fish movement. Despite this, significant seal damage was recorded in salmon returns during the period June to August, when fifteen per cent (261 of the 1730 ranched salmon processed during these months) were recorded with seal damage. Overall, 11.6% of total returns were recorded with damage (267/2294).

Broodstock collection commenced from August 6th onwards and salmon were held in ponds until transfer to the broodstock holding pond on 11th and 13th September 2012 (144 males, 151 females).

Broodstock collection continued into December and in total, 521 ranch adults (247 females, 274 males) were held during the stripping period.

Average water temperatures ranged between 6^0C and 7^0C during December and early January. Stripping commenced on December 4th 2012 and extended over an 8 week period to January 28th 2013. Branded, damaged and small females were culled prior to commencement of stripping (n=43) and during stripping (n=10). At the end of the season, 15 hens remained unready to strip. An estimated 525,700 green ova were produced by 179 females. Ova from parents with no tag and from non-indigenous groups, as indicated by microtag, were removed. Ova from branded fish were held separately. Approximately 346,200 green ova were produced by 119 Burrishoole ranch females. The average fecundity value was 3,049 ova per grilse female (n=97) and 4,770 ova per 2SW female (n=5). A proportion of each family, from confirmed Burrishoole stock, was retained in the hatchery from each of the eight stripping dates, totalling 71,862 eyed ova from 119 females (including 4 2SW and 7 wild ranch) and 122 males (including 8 wild ranch). Ova quality and survival was good.

Returns from one of the branded experimental groups produced in December 2009 (derived from 10 'Burrishoole origin' 2SW females recovered and stripped in Delphi Hatchery, crossed with 10 Burrishoole ranch grilse males) were unexpectedly high, particularly as the female parents were of two-sea-winter origin. Despite culling branded fish as they were recovered in the traps, a significant number of this group were found in the broodstock and an experimental group of 11,550 eyed ova derived from these returns (17 females x 17 males) was produced and retained for on-growing.

Broodstock condition was good throughout the holding period. Thirty ranch salmon broodstock were sampled in January 2013 and certified by the Marine Institute Fish Health Unit as disease free. During 2012, 117 salmon were sampled to assess the incidence of *Anasakis* and post larvae of the cestode *Hepatoxylon trichiuri,* which were noted in 2011. *Anasakis* was observed in 82.9% of fish sampled and where present recorded as low (< 10 per fish) 59.8%, medium (10-50 per fish) 36.1% and high (>50 per fish) 4.1%. The presence of *H. trichiuri* was noted in 34.2% of fish sampled, and was generally found in the body cavity. Where present, 90% were recorded with 1 or 2 cestodes and 10% with 3 or 4 cestodes.

3.4 Rainbow Trout 2012

There were no stocks of rainbow trout on site in 2012.

3.5 Virological Screening of Wild Salmon Stocks 2012

A sampling programme for wild salmon kelts, over two years, was agreed with the Marine Institute Fish Health Unit in 2011.

3.5.1 Wild Salmon Kelt Sampling 2012

Wild salmon kelts were collected from the downstream traps and sampled between 10.02.12 and 20.03.12. Scale and fin samples were taken and length, weight, sex, condition, and the presence/absence of *Anasakis* were recorded (Table 3.1). Kidney samples were placed in RNA later and frozen and a small piece of tissue was taken from the liver, spleen, kidney and pyloric caecae organs and frozen. RNA later samples were sent to the Fish Health Unit, MI Galway, for IPN testing. All fish tested negative for IPNV by real-time RT-PCR.

Table 3-1: Wild Salmon Kelt Data Summary 2012.

	Female	Male
Number of kelts sampled	76	22
Range in Length (cm)	45.3 –78.6	47.0-63.7
Range in Weight (kg)	0.63-3.38	0.7-1.89
Number of Fish: Condition A or B	74A, 2B	22A
Number of Fish: *Anasakis* observed	67 (88.1%)	19 (86.3%)

During kelt sampling, some eggs were noted in the body cavity of the majority of females (Table 3.2). Two of the 76 female kelts sampled had failed to spawn, representing 2.6% of the females sampled. Ovaries were immature in one small female (45.3cm), and over ripe eggs were retained in the egg sacs of one large female (67.6cm). Overall, fish condition was good and the incidence of *Anasakis* observed was low. The majority of fish sampled in March had small amounts of food in the gut.

Table 3-2: Estimated number of ova retained in the body cavity of wild salmon kelt females sampled from downstream traps, February/March 2012

Estimated number of eggs retained in the body cavity	Number of females (n = 76)
0 – 10 eggs	63
11 – 50 eggs	11
51 – 200 eggs	0
All eggs retained	2

3.6 Acoustic Tracking Programme

3.6.1 2012 Project

The acoustic tagging programme commenced in 2010 with a pilot programme with a view to examining behavioural differences and environmental preferences of wild and ranch adult salmon in Lough Feeagh. A more extensive programme followed in 2011 whereby 11 wild and 10 ranch adult salmon were tagged with acoustic temperature/depth tags (20 Vemco V13TP, 1 Thelmabiotel ADTT-13) during July and August. Eight receivers were moored in Lough Feeagh, providing close to full coverage, and one receiver was placed in each of the Black and Glenamong Rivers.

In 2012, a further 10 wild and 7 ranch salmon were tagged with acoustic temperature/depth tags or depth tags (4 VemcoV13TP, 10 VemcoV13P, 2 Thelmobiotel ADTT-13) between July and September 2012. Data should provide novel insights into fish behaviour and inform important thematic research areas 'interactions of wild and cultured salmon' and 'climate change'. A scatter graph showing average hourly depth records for one wild female salmon is shown in Figure 3.1.

Spawning is considered to have taken place between 26th November and 17th December 2011, when the fish was absent from the lake and detected on the Black River receiver.

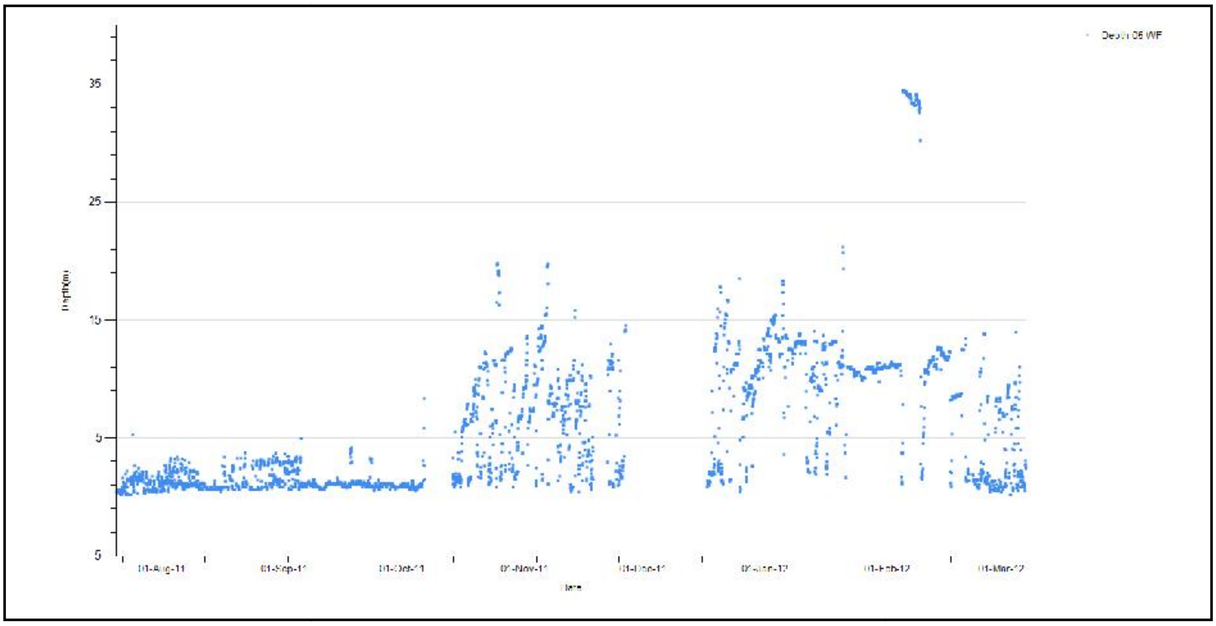


Figure 3-1: Scatter plot showing average hourly depth records for an acoustically tagged wild female salmon in Lough Feeagh from August 2011 to March 2012.

4 Salmon Census Programme

The salmon census and stock assessment programme was continued in 2012 with a full upstream and downstream census of migrating wild salmon. The data provides a valuable index of salmon survivals and stock dynamics for the freshwater components of the stock.

4.1 Wild Salmon and Grilse

A total of 671 wild grilse, and 6 previously spawned grilse, were recorded moving upstream through the permanent traps during the season (Table 4.1). The upstream migration of wild salmon commenced in May. Water levels remained sufficiently high for much of the summer and in addition the damming of the Mill Race channel increased water flow through the Salmon Leap from Mid April to mid July.

The main upstream grilse migration was therefore concentrated in the Salmon Leap trap with 640 grilse, compared to 31 grilse in the Mill Race trap.

The total number of spring fish recorded in the upstream traps was 18.

No wild fish were retained in the rod catch of wild grilse on Lough Furnace and therefore the total wild grilse return to freshwater was **671** and **6** previously spawned grilse.

The recent trend of an increase in the June upstream migration of wild grilse continued in 2012 with 29.8% of the run recorded in June compared to 16.8% in 2011 and 0.9% in 2010 (Table 4.2) and 87% of the run was complete by the end of July.

Table 4-1: Monthly wild grilse totals for the Salmon Leap and Mill Race traps, 2012.

	Mill Race	Salmon Leap	Total	%
May	0	1	1	0.1
June	0	200	200	29.8
July	20	363	383	57.1
August	5	63	68	10.1
September	6	10	16	2.4
October	0	3	3	0.4
November	0	0	0	0.0
December	0	0	0	0.0
	31	640	671	100

Table 4-2: Monthly proportions (%) of the wild grilse run timing 2004-2012.

	2004	2005	2006	2007	2008	2009	2010	2011	2012
May	0.0	0.4	0.5	0.3	0.0	0.0	0.0	0.2	0.1
June	36.0	23.9	1.4	7.7	9.1	4.6	0.9	16.8	29.8
July	41.0	13.2	40.1	56.3	17.9	78.7	75.8	43.4	57.1
August	9.8	39.1	31.9	17.5	62.6	15.5	15.5	29.8	10.1
September	10.9	14.8	22.8	14.9	7.3	0.9	6.7	8.4	2.4
October	1.0	5.5	2.5	1.0	2.9	0.2	1.0	0.6	0.4
November	0.7	3.0	0.5	1.3	0.2	0.2	0.1	0.8	0.0
December	0.5	0.2	0.3	0.8	0.0	0.0	0.0	0.0	0.0

Table 4-3: Wild salmon, grilse and previously spawned grilse (PSGs identified from floy tag recoveries) totals in the upstream traps, 1970-2012.

Year	Total Salmon	Total Grilse	Previously Spawned Grilse
1970-74	14	1145	
1975-79	36	703	
1980-84	35	449	
1985-89	22	492	
1990-94	16	421	
1995-99	12	509	
2000-'04	12	542	
2005-'09	22	642	
1995	15	582	
1996	18	409	
1997	6	538	
1998	4	516	
1999	16	502	
2000	6	568	
2001	6	368	
2002	2	648	
2003	18	544	
2004	28	580	
2005	9	532	
2006*	31	530	
2007*	12	1049	
2008	23	548	21
2009	37	549	10
2010	17	686	17
2011	50	523	7
2012	18	671	6

* years where the grilse count was raised to account for loss in the traps.

4.2 Net marked fish in upstream traps

In 2007, the Irish Government introduced a cessation on drift netting in Irish coastal waters. The overall incidence of net marks recorded since the cessation in 2007 remains very low. The overall incidence of net marks was similar for both wild and ranched fish at 1.9% and 1.8% respectively (Table 4.4). The highest monthly occurrence for wild fish was in August when 3 of 42 fish examined were net marked and for ranched fish in July when 16 of 768 fish were net marked. The high flow rates for much of the summer were not ideal conditions for netting and may have contributed to the low incidence of net marks.

Table 4-4: Percentage occurrence of net marks on wild and reared grilse, 2012.

	Wild Grilse %	Number examined wild/month	Reared Grilse %	Number examined reared/month
May	0.0	1	0.0	0
June	0.7	148	1.4	218
July	1.9	266	2.1	768
August	7.1	42	2.0	202
September	0.0	13	1.5	132
October	0.0	3	0.0	36
November	0.0	0	0.0	13
December	0.0	0	0.0	0
Total number	1.9%	473	1.8%	1369

4.3 Wild Spawning Stock

The spawning stock (escapement) represents the number of fish available for spawning. It is calculated by subtracting rod caught fish and downstream-displaced fish as well as losses due to poaching, disease and predation, which have been estimated at 5% for wild fish and 10% for reared fish.

In both 2006 & 2007, an additional number of fish, reared and wild, escaped upstream undetected (see previous reports). It is likely that the wild grilse count for those years were minimum figures and this was taken into account for all calculations based on the 2006 & 2007 spawning escapements.

4.3.1 Spawning escapement and stock

The total spawning stock in 2012 consisted of 640 wild fish and 28 reared fish (Table 4.5). The reared component was derived from 128 reared fish which were released upstream between June and September to provide an early component of reared returns for broodstock. A total of 97 reared fish were recaptured in the downstream traps prior to the spawning season. 87 fish were retained as broodstock, which included 5 fish which had been released downstream and were subsequently recaptured in the upstream trap and transferred to the broodstock holding facility.

Table 4.6 gives the annual total spawning escapement, the wild escapement and the reared fish component. The spawning escapement of wild fish in 2007 was the highest observed over the last two decades. Particularly poor wild escapement was recorded in the 1990s and in 2001.

Table 4-5: Spawning stock of salmon and grilse, 2012.

	Wild grilse (1SW) & previously spawned grilse	Wild Salmon (2SW)	Ranched fish released upstream
Counted in trap	677	18	128
Rod Feeagh	0	0	0
Culled	3*	0	6
Broodstock	2*	0	87
Estimated morts.	33	1	3
Displacement	16	0	4
Spawning stock	**623**	**17**	**28**

* See Chapter 4.3.2.

Table 4-6: Spawning escapement, 1970-2012.

	Maximum spawning escapement	Wild fish component	Reared fish component
1970-74	1126	986	140
1975-79	725	683	42
1980-84	474	430	44
1985-89	662	428	232
1990-94	603	348	254
1995-99	519	428	95
2000-'04	516	494	21
2005-'09	624	587	38
1995	464	376	102
1996	594	355	239
1997	494	466	28
1998	498	456	42
1999	547	485	62
2000	567	527	40
2001	370	349	21
2002	570	562	8
2003	517	506	11
2004	554	528	26
2005	503	472	31
2006	552	520	32
2007	1038	958	80
2008	512	495	17
2009	517	489	28
2010	652	617	38
2011	548	512	36
2012	668	640	28

4.3.2 Wild salmon broodstock stripped December 2011/2012

In 2012, 11 males and seven females were collected from the Shrarevagh River and two females from the SLDT.

Of the 11 males, four were released again before spawning and four were used as broodstock, although their progeny were released back into the river. The remaining three were culled and sampled.

Of the nine females, three were released again before spawning and four were used as broodstock, although their progeny were released back into the river. The remaining two from the SLDT were culled and sampled.

The fish captured and released, and those whose progeny were released again, were not included in the Table 4.5 either as culled fish or broodstock.

4.4 Survival from Ova to Grilse

The relevant brood year for the 2012 grilse was 2008 with ova hatched in 2009 and smolt migration in 2011 (Table 4.8). As in previous years, it has been assumed for the purpose of estimating survival that ranched grilse spawned naturally. Specific data are not currently available on differential survival rates of wild and ranched stocks spawned in the wild. All relevant calculations are based on parameters set out in the Ann. Rep. No. 19, 1974.

Table 4-7: Survivals from ova to smolt and smolt to grilse.

Spawning escapement in 2008	512
No. of females	256 - 282
Ova deposition	1,024,000 – 1,158,784
No. of smolts in traps 2011	6629
No. of smolts released	6390
Survival ova to smolt	0.65-0.57
No. returning grilse 2012	671
Survival smolt to grilse	10.5%
Survival to grilse per grilse female	***2.6 – 2.4***

* two estimates of the % females in the run using 50% and 55%

4.5 Ova to Smolt Survival

The maximum survival of ova to smolt recorded in 2011 was 0.6 from a spawning escapement of 512 spawners. It was double that of the previous year (0.3), from a spawning stock of 1038 in 2007. For the five years prior to 2007 the average spawning stock was 539 and the average survival of ova to smolt was 0.7.

The percentage return of grilse increased from 7.5% to 10.5% from a smolt migration of 6390. Water levels were high for most of the summer and enabled fish to migrate directly upstream to Lough Feeagh.

The survival to grilse per grilse female was 2.4 – 2.6 (Table 4.8).

Table 4-8: Percent survivals for ova to smolt and grilse per female grilse spawner; comparative data for 5-year averages from 1970-1989 and values for the individual brood years from 1990 onwards.

Brood year-class	% survival rates ova to smolt	survival rates to grilse per grilse female spawner
1970-74	0.48 - 0.62	1.4 - 1.7
1975-79	0.63 - 0.73	1.5 - 1.7
1980-84	0.61 - 0.69	1.7 - 1.9
1985-89	0.44 - 0.45	1.4 - 1.5
1990	0.47 - 0.54	1.8 - 2.0
1991	0.47 - 0.53	1.8 - 2.0
1992	0.48 - 0.54	1.3 - 1.5
1993	0.39 - 0.45	1.5 - 1.6
1994	0.36 - 0.41	1.3 - 1.4
1995	0.83 - 0.93	1.9 - 2.1
1996	0.53 - 0.61	1.8 - 1.9
1997	0.52 - 0.59	1.4 - 1.5
1998	0.58 - 0.60	2.4 - 2.6
1999	0.79 - 0.70	1.8 - 2.0
2000	0.56 - 0.64	1.9 - 2.1
2001	1.30 - 1.10	2.9 - 2.6
2002	0.56 - 0.64	1.7 - 1.9
2003	0.68 - 0.76	3.7 - 4.1
2004	0.53 - 0.60	1.8 - 2.0
2005	0.69 - 0.61	2.0 - 2.2
2006	0.75 - 0.67	2.4 - 2.6
2007	0.34 - 0.30	0.9 - 1.0
2008	0.65 – 0.57	2.4 - 2.6

4.6 Wild Salmon Smolts

A total of 7717 smolts were recorded in the downstream traps in 2012 (Table 4.9). The smolt migration commenced on March 18th and water flow conditions remained favourable for downstream migration until the end of April (Fig. 4.1). During early May water levels were low. Following the damming of the Mill Race on the 15th May, however, water flow through the Salmon Leap increased and a second peak in migration was recorded on the 16th May.

Note: during the period that the Mill Race was dammed (for replacement works on the Mill Race Trap) the water level and temperature recorders were moved upstream into the Lough Feeagh EPA recording hut. This is indicated on Figure 4.1.

The total numbers of wild salmon smolts increased from 6629 in 2011 to 7717 in 2012 (Table 4.10).

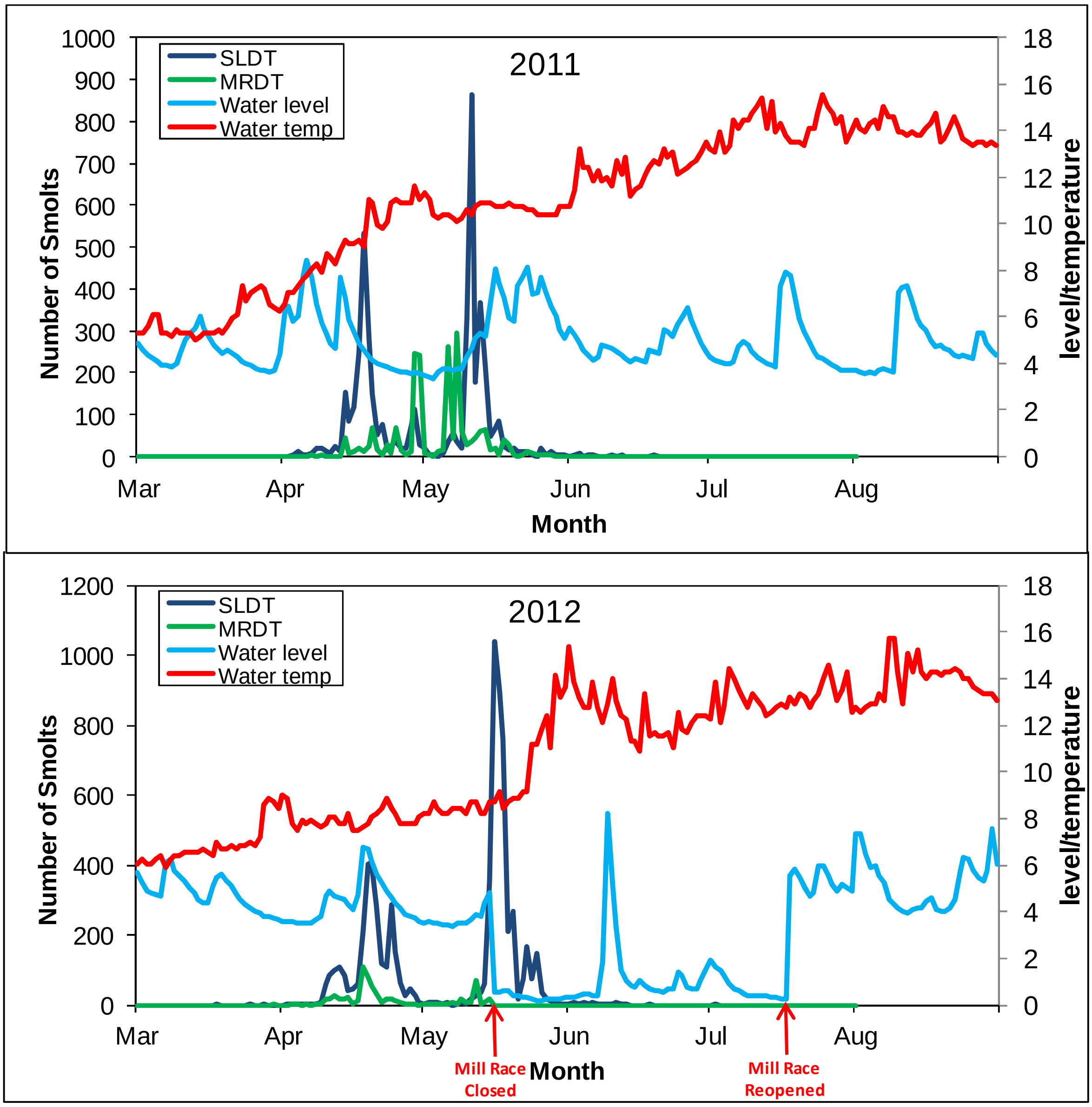


Figure 4-1: Timing of the 2011 and 2012 wild salmon smolt runs in the Salmon Leap and Mill Race traps with daily midnight water level (m x 10) and midnight temperature (^{0}C). Two smolts recorded in September 2011 were not shown. Note Mill Race closed with a dam at the upstream end from 16h May to 17th July 2012.

Table 4-9 : Number of wild salmon smolts counted in 2012.

Month	Salmon Leap Down Trap	Mill Race Down Trap	Total
March	3	1	4
April	2762	487	3249
May	4267	147	4414
June	47	0	47
July	1	0	1
August	1	1	2
September	0	0	0
TOTAL	7081	636	7717

Table 4-10: Annual numbers of wild salmon smolts recorded in the downstream traps.

Year	1990-94	**1995-99**	**2000-04**	**2005-09**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Smolts Counted	5618	7052	7490	7351	7918	6685	6909	7980	7123	6629	7717
Smolts Released		6967	7340	7138	7701	6518	6691	7749	6979	6390	7542

4.7 Wild Salmon Kelts

4.7.1 Census

Kelts migrate downstream after spawning. Water levels were high during January and February and the highest monthly percentage of migrating salmon kelts was recorded in February when 40% of the total migration was recorded (Table 4.11).

The overall survival of kelts from the spawning stock increased from 35.5%, in 2011 to 54.7% in 2012 (Table 4.12).

A total of 98 wild salmon kelts (76 female and 22 male) were culled from the downstream traps for IPN screening (see Section 3.5.1).

Table 4-11: Numbers of wild salmon kelts counted in 2012.

Month	SLDT	MRDT	Total
December ‘11	4	3	7
January ‘12	12	9	21
February	95	17	112
March	83	5	88
April	46	4	50
May	1	0	1
June	1	0	1
Total	242	38	280

4.7.2 Tagging of wild kelts

Following the cessation of drift netting during 2007 and the corresponding increase in the wild spawning stock at Burrishoole tagging of the wild kelts recommenced during 2008. A total of 165 floy tagged kelts were released from the downstream traps in 2012. During the summer of 2012 a total of 6 previously spawned grilse were recovered. The percentage recovery of PSGs for 2012 was 3.6% (Table 4.12).

Table 4-12: Comparison of annual salmon kelt runs.

Year	Kelt Quality Grade				
	A	B	C	D	E
1975-79	75	18	14	30	8.1
1980-84	82	18	6.7	48.7	9.7
1985-89	88	21	5.1	43.2	8.4
1990-94	92	31	4.8	61.4	6.6
1995	74	28	18.3	59.9	2.3
1996	88.1	27	10.1	53.1	4.0
1997	93.7	33.5	6.3	58.9	*
1998	94.3	30.8	5.7	67.6	*
1999	90.6	38.5	4.5	76	*
2000	92.5	44.5	5.5	62.1	*
2001	97	38.5	2.8	72.5	*
2002	91.3	40.9	7.8	49.6	*
2003	95.5	37	3.5	42.3	*
2004	89.9	36.3	9	53.2	*
2005	83.3	35.5	15.3	57.6	*
2006	82.2	36.1	16	54.4	*
2007	95	37.3	4.1	**	*
2008	93.2	26.9	6.8	**	5.6
2009	96.1	20.8	3.3	43.8	4.9
2010	98.1	13.5	1.3	34.2	10.1
2011	95.9	22.7	0.5	35.5	4.1
2012	96.7	20.8	2.8	54.7	3.6

* no kelt tagging

** see section 4.7 (2007 report)
A = % healthy kelts in kelt run
B = % males in kelt run
C = % lightly marked
D = % survival from wild spawning escapement
E = % recapture of previously spawned grilse in first year

5 Reared Salmon Census Programme

A programme of rearing and releasing tagged salmon has been carried out in Burrishoole since the early 1960s. The stock was based originally on donor wild salmon from the Burrishoole system and the stock has been closed since using returning tagged fish as broodstock. Additional experimental groups are sometimes released and these are freeze branded and differentially tagged so as to avoid mixing these with the core ranched stock. The ranched stock facilitates data collection and comparison with the wild stock without putting undue stress or mortality on the wild stock – in this report the ranched stock are known as reared grilse and reared 2SW salmon.

5.1 Coastal Returns

Details of coastal returns of Burrishoole fish are available in the Marine Institute 'National Report for Ireland - The 2012 Salmon Season' report.

5.2 Return rate of reared and wild grilse

A total of 2383 microtags were recovered from reared fish returning to Burrishoole in 2012. Of the total recovery 1653 were identified as Burrishoole core fish, of which 1601 were grilse and 52 were 2SW fish.

The average return rate of reared Burrishoole grilse to freshwater, as determined by microtags, was 2.7% in 2011 and it increased in 2012 to an average return of 4.89%.

For comparison, the percentage return of wild grilse increased from 7.5% in 2011 to 10.5% in 2012.

5.3 Recapture of Reared 2SW Fish

The total number of microtagged 2SW reared fish recorded in Burrishoole during 2012 was 70 comprising of 6 core release groups (52 returns) and 1 experimental release group (18 returns). There were three 3SW returns from an experimental group released in 2009.

5.4 Smolt Releases 2012

A total of 41,446 ranched smolts were released from Burrishoole during 2012. All of the smolts released as part of the on-going core ranching programme and no additional experimental groups were released. All of the smolts were released into Lough Furnace on 26^{tth} April. For additional information, see section 3.1.1.

Table 5-1: Details of microtag codes and smolt release groups 2012.

Group ID	Tag Code	Mean Wt	Mean Length	No. Re-leased	Date re-leased
Core	64731	76.03	18.53	4,339	26/04/2012
Core	64732	73.29	18.35	8,018	26/04/2012
Core	64733	78.88	18.7	3,746	26/04/2012
Core	64734	65.09	18.11	6,399	26/04/2012
Core	64735	63.18	17.47	6,978	26/04/2012
Core	64736	73.64	18.37	5,991	26/04/2012
Core	64737	70.66	18.64	5,975	26/04/2012

5.5 Reared kelts

In 2011 a total of 125 ranched fish were released upstream into Lough Feeagh. Between July and December, 85 (68%) of the fish released up were recaptured in the downstream traps the majority of which were retained as broodstock in the Smolt Unit. During 2012 a further 21 ranched fish were recorded as kelts in the downstream traps. Therefore the total recovery of ranched fish released upstream in 2011 was 106 (84.8%) of the 125 fish.

In 2012 a total of 128 ranched fish were released upstream during the summer. By the end of December 2012 a total of 97 fish (76%) were recaptured in the downstream traps of which 85 were transferred to the broodstock ponds.

In 2013, an additional 19 ranched grilse were recorded in the downstream traps. Therefore a total of 116 (91%) of the 128 fish released upstream in 2012 were accounted for in the downstream traps.

6 Wild Sea Trout Census Programme

The sea trout monitoring programme was continued in 2012.

6.1 Upstream Movements: Timing and Numbers.

A total of 139 wild silvered sea trout and a further 47 non-silvered trout migrated upstream through the traps in 2012. Of the silvered trout, 35 were adults and 104 (74.8%) were finnock. The numbers are compared with other years in Table 6.1. Of the total run of migratory trout (186), 25.3% were unsilvered. For the purposes of this report, the unsilvered trout are not included with the sea trout. Table 6.1 shows that the numbers of sea trout have not recovered in the Burrishoole system and have shown a ten-fold drop since the 1970s.

Table 6-1: Annual runs of sea trout recorded in the traps.

Year	Mill Race	Salmon Leap	Total	Amended Total
1970-74	1365	762	2127	
1975-79	829	1775	2604	
1980-84	458	780	1238	1719 *
1985-89	386	590	978	
1990-94	134	72	206	
1995-99	86	91	177	
2000-04	32	64	97	
2005-09	21	44	65	
2000	33	78	111	
2001	31	58	89	
2002	26	89	115	
2003	45	33	78	
2004	26	64	90	
2005	5	10	15	
2006	16	22	38	
2007	35	59	94	
2008	4	36	40	
2009	45	93	138	
2010	10	62	72	
2011	15	53	68	
2012	19	120	139	

* See Table 34, Ann. Rep. XXX (1985); p. 43.

The timing of the sea trout run in 2012, and in previous years, expressed in monthly percentages, is given in Table 6.2. The highest proportion of sea trout, both finnock and adults, moved upstream in July. There was a small movement upstream of what appeared to be smolts (6) in April and May. The unsilvered trout moved upstream from June to December with no notable peaks.

Table 6-2: Timing of the Burrishoole (a) silvered sea trout run and (b) unsilvered trout run (in monthly percentages). (n = no. of trout).

(a) Silvered Trout

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04 (483)	2005-'09 (325)	2008 (40)	2009 (138)	2010 (72)	2011 (68)	2012 (139)
May	-	0.2	0.5	0.1	3.1	2.0	1.3	0.0	0.0	0.0	13.2	1.4
June	13.1	24.6	9.4	8.4	8.6	16.7	9.0	0.0	2.2	0.0	0.0	11.5
July	54.4	44.9	62.2	55.0	42.4	37.5	32.5	10.0	88.4	85.9	16.2	60.4
August	15.8	10.3	18.4	16.5	19.3	26.4	38.1	82.5	6.5	8.5	35.3	18
September	7.6	14.8	3.7	8.5	9.8	5.7	13.6	5.0	0.7	5.6	22.1	5
October	6.4	3.5	4.1	7.9	12.2	10.2	4.7	2.5	2.2	0.0	7.4	2.9
November	2.4	1.5	1.5	2.9	4.3	1.5	0.7	0.0	0.0	0.0	5.9	0.7
December	0.3	0.2	0.2	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0

(b) Unsilvered Trout

	2005 (86)	2006 (61)	2007 (94)	2008 (76)	2009 (91)	2010 (104)	2011 (87)	2012 (47)
April	0	0	2.2	2.6	2.2	0.0	3.4	0
May	4.7	16.4	5.4	3.9	5.6	1.0	5.7	0
June	10.5	9.8	19.4	13.2	8.9	0.0	3.4	21.7
July	4.7	16.4	25.8	21.1	23.3	44.2	12.6	17.4
August	43	11.5	4.3	31.6	12.2	16.3	14.9	13.0
September	12.8	13.1	6.5	7.9	7.8	17.3	11.5	13.0
October	9.3	27.9	7.5	9.2	24.4	7.7	11.5	19.6
November	10.5	3.3	20.4	2.6	14.4	11.5	36.8	6.5
December	4.7	1.6	8.6	7.9	1.1	1.9	0.0	8.7

6.2 Spawning Escapement

With the continuation of the catch and release bye-law into the 2012 fishing season, no sea trout were reported killed by anglers on L. Feeagh in 2012. Using the upstream fish counts through the traps, the total maximum spawning escapement of migratory trout to the L. Feeagh catchment was 200, of which 57 were non-silvered sea trout.

Table 6-3: Annual spawning escapement of sea trout into freshwater, 1970-2012.

	1970-'79	1980-'84	1985-'89	1990-'94	1995-'99	2000-'04	2005-'09	2008	2009	2010	2011	2012
Max. Escap.	2090	1146	906	231	289	156	146	116	228	175	155	186
Revised	1622											

6.3 Downstream Movements, Sea Trout Smolts

The 2012 smolt run amounted to 632 smolts, of which 617 were released downstream to the wild (Table 6.4). Few smolts were recorded from January to March. The main migration occurred in April (62%) and May and was strongly regulated by both water level and water temperature (Fig. 6.1). The 2012 smolt count, while still low, was much improved compared to 2010 and similar to 2009 and 2011 (Table 6.5).

Table 6-4: Monthly numbers of Burrishoole sea trout smolts recorded through the traps.

Month	Salmon Leap	Mill Race	Total	%
January	14	2	16	2.5
February	9	1	10	1.6
March	11	2	13	2.1
April	369	26	395	62.5
May	131	15	146	23.1
June	47	0	47	7.4
July	5	0	5	0.8
Total	586	46	632	
Number Released Downstream			617	

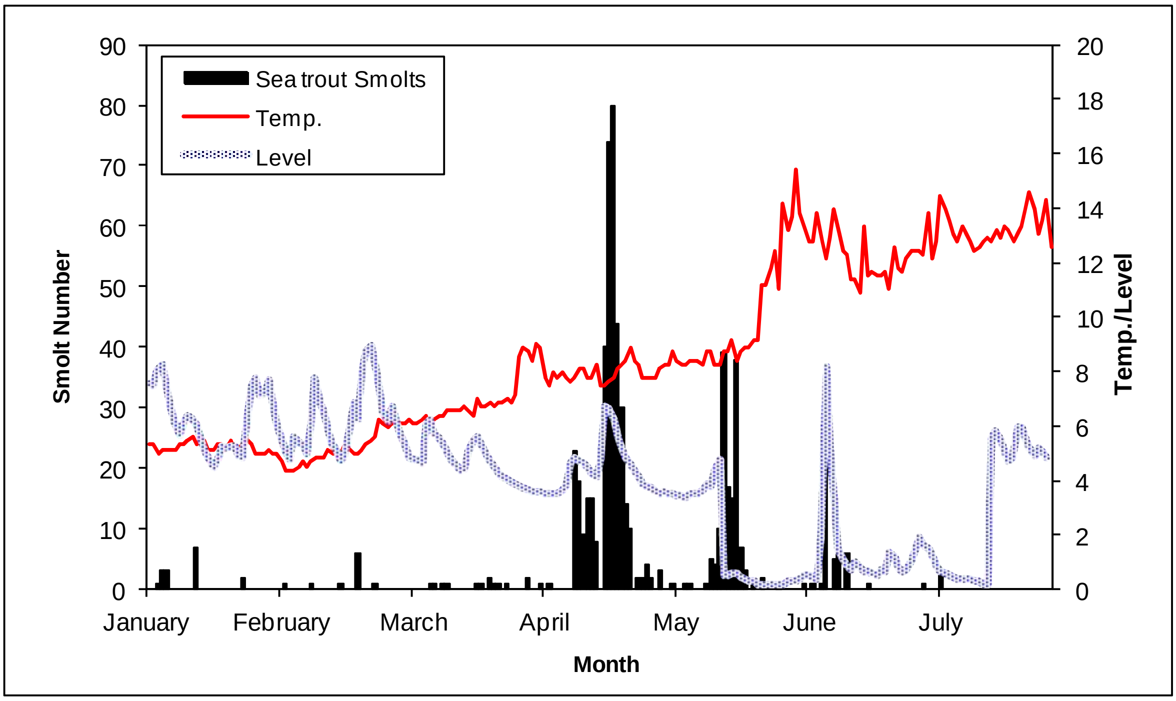


Figure 6-1: Timing of the 2012 wild sea trout smolt migration with daily midnight water level (m x 10) and midnight temperature (^{0}C). Note Mill Race closed from 16th May to 18th July 2012.

Table 6-5: Annual sea trout smolt numbers in Burrishoole for 1970 to 2012.

	1970-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2008	2009	2010	2011	2012
Number	4176	4038	4119	1531	1361	816	609	393	657	213	620	632

A total of 411 wild smolts were measured in 2012. Length measurements were taken to facilitate an estimated age breakdown of the smolt run. The estimated statistics for the 2012 smolts were a mean length of 20.0 cm and a range from 14.4 to 29.0 cm and the length frequency is presented in Figure 6.2 compared with that of 2011. This gave an estimated age of 82% 2 year old and 18% 3 year olds.

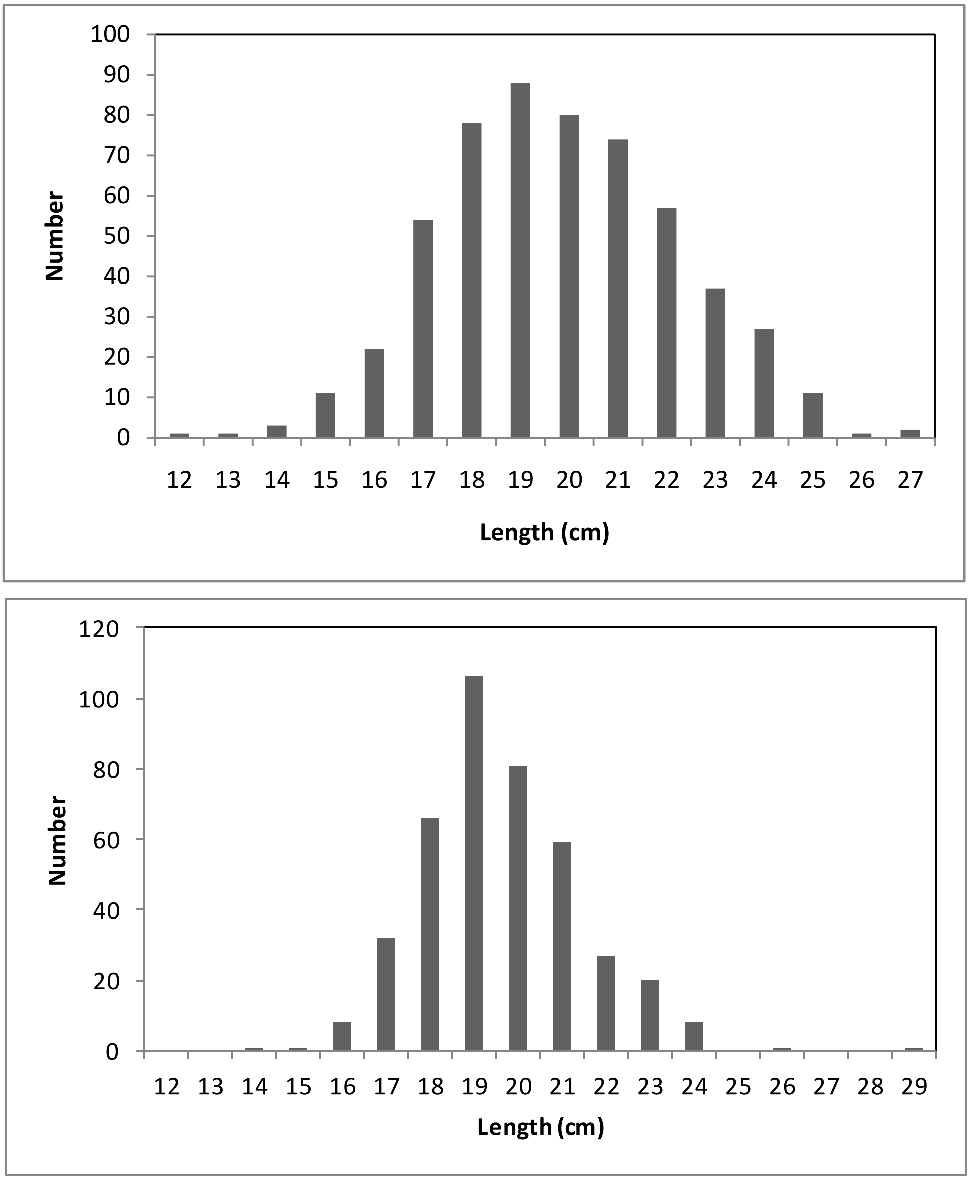


Figure 6-2: Length distribution for smolts in the Burrishoole system, top graph 2011 (n=547) and bottom graph 2012 (n=411).

6.4 Autumn Migrating Smolts

These are juvenile trout (*Salmo trutta* L.) which generally move downstream through the traps from August to December. It is not clear whether these are true sea trout or part of the resident trout stock being displaced downstream. It is known through mark-recapture studies that a proportion of the 1+ autumn trout do return the following year as silvered finnock. These runs of trout would appear to becoming more prolonged with substantial numbers of un-silvered 0+ and 1+ trout continuing to migrate downstream in the early months of the year.

A total of 1018 trout entered the traps between July and December 2012 and up to May 2013 (Table 6.6). The percentage of 0+ trout that migrated over the period was 47.3% (Table 6.7).

Table 6-6: Numbers of migrating autumn juvenile trout in 2012, to the end of May 2013.

	0+		1+		Total	
Month	Salmon Leap	Mill Race	Salmon Leap	Mill Race	Salmon Leap	Mill Race
July	3	0	8	0	11	0
August	27	0	13	0	40	0
September	97	2	103	6	200	8
October	131	5	141	17	272	22
November	85	4	108	12	193	16
December	59	1	47	1	106	2
January '13	28	2	40	8	68	10
February '13	14	0	14	1	28	1
March '13	7	0	1	2	8	2
April '13	12	0	5	0	17	0
May '13	4	1	8	1	2	0
Total	467	15	488	48	955	63
Overall Total	**482**		**536**		**1018**	

Table 6-7: Percentage of 0+ juvenile trout in the trapped autumn migrating trout.

Year	% 0+	Year	% 0+
1982	50.0	1998	33.5
1983	N/A	1999	42.0
1984	55.8	2000	47.8
1985	30.3	2001	56.3
1986	16.1	2002	32.8
1987	35.3	2003	48.9
1988	60.9	2004	35.5
1989	37.2	2005	37.3
1990	35.2	2006	51.2
1991	26.0	2007	27.9
1992	38.2	2008	28.2
1993	27.6	2009	25.0
1994	16.8	2010	34.9
1995	25.3	2011	37.6
1996	34.0	2012	47.3
1997	18.7		

6.5 Total Recruitment

The 0+ autumn trout will not be large enough to become sea trout smolts in the following spring. The remainder, predominantly 1+ year olds, could contribute to the overall recruitment of sea-run trout the following year. The exact proportion of 1+ autumn trout that become smolts in any given year is not known. It is only since 1982 that the proportion of 0+ trout amongst the autumn migration has been estimated. Thus the figures for total recruitment up to this time are over-estimated (Table 6.8).

From 1982, total recruitment was calculated by adding the number of sea trout smolts produced in any one year to the total of 1+ autumn trout the previous year (Table 6.9). The assumption is made that all the 1+ autumn trout will become sea trout smolts and that no 0+ trout from the two years previous will be recruited as smolts. The fate of 1+ unsilvered juveniles migrating downstream in January to May is unknown but it would seem unlikely that these will contribute to the 2 year old spring smolt migration.

Table 6-8: Estimates of total migrant trout recruitment up to 1981.

Year	Smolt Total	Autumn trout (preceding year)	Total Recruitment
1970-74	4450	2870	6746
1975-79	4314	3186	7489
1980	2337	2351	4688
1981	6710	2631	9341

Table 6-9: Estimates of total migrant trout recruitment from 1982 to date.

Year	Smolt Total	1+ Autumn trout (preceding year)	Total Recruitment
1982-84	3714	1203	4917
1985-89	3706	1063	4778
1990-94	1788	399	2187
1995-99	1361	498	1860
2000	769	358	1127
2001	530	218	748
2002	1272	910	2100
2003	787	976	1763
2004	723	426	1149
2005	777	590	1367
2006	628	251	879
2007	593	377	970
2008	393	534	927
2009	657	495	1152
2010	213	267	480
2011	620	501	1121
2012	632	493	1125

6.6 Marine Survival

An estimate of sea trout survival to first return to freshwater can be more accurately calculated by the use of trap census data rather than rod catch returns of tagged or marked fish. Small numbers of stray fish are captured in other systems and it is not known whether these fish would have returned to their natal systems to spawn. Finnock are known to wander between river systems and are therefore not as reliable for assessing survival.

The pattern of marine survival found is similar whether the number of smolts is used or the combined total recruitment of smolts and autumn 1+ trout. The percentage of smolts that return as finnock (0+ sea age) in the same year historically ranged from 11.4% to 32.4% (Fig. 6.3). In 1988 it fell below the previous recorded minimum to 8.5% and in 1989 to a minimum of 1.5%. There has been a saw-tooth pattern of finnock return in the 1990's rising to 16.7% in 1999, 18.1% in 2009 and 17.5% in 2010 – the highest return rates since 1986. These increases were not, however, always sustained in subsequent years and there was a collapse in 2005 down to 1.5%. This was associated with the heaviest infestations of sea lice observed in the Burrishoole area since 1992. The return in 2011 fell to 8.1% and increased to 16.9% in 2012.

The total survival of smolts to their first return to freshwater as finnock in the same year and one year old sea trout in the following year (always an over-estimate as a proportion of finnock re-entering freshwater in year 1 return as sea trout in year 2 (Mills *et al*, 1990)) also showed a drop in survival from 1987 to 1989 (Fig. 6.4).

Historically, the total survival to first return ranged from 19% to 66%. This collapsed to 1.8% in 1989 but rose to 12.1% in 1990. However, little further improvement was recorded in 1991 (12.8%). Marine survival fell to the second lowest level in 1992 but returned to 13.1% for the 1993 year class of smolts. There was a further increase in 1994 to 18.2% but a drop in 1995 to 8.1%. There were marginal improvements again in 1996 (12.8%) and 1997 (13.3%), a drop to 8.3% in the 1998 year class and a marked improvement in the 1999 year class where marine survival was 20%, the highest recorded in 12 years and back within the pre-collapse historical range. Total survival increased for the 2009 cohort to the highest recorded level since 1988 of 23% and to 25.1% for the 2010 cohort. For the 2011 cohort of smolts, it fell to 13.5%.

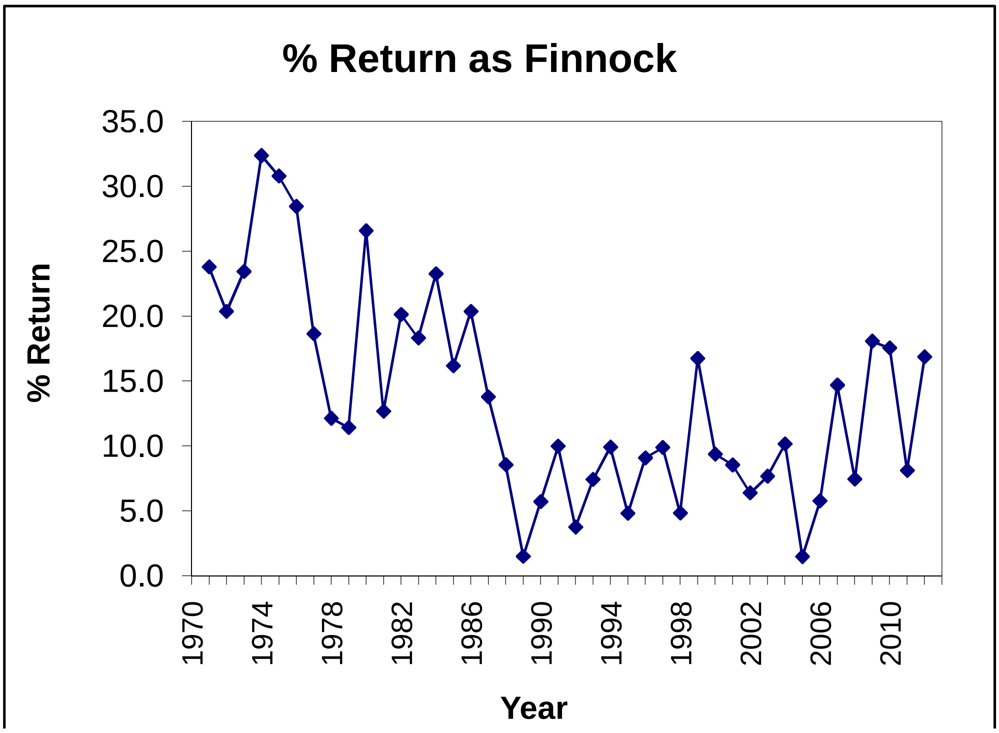


Figure 6-3: Annual percentage return of smolts returning as finnock to the Burrishoole system.

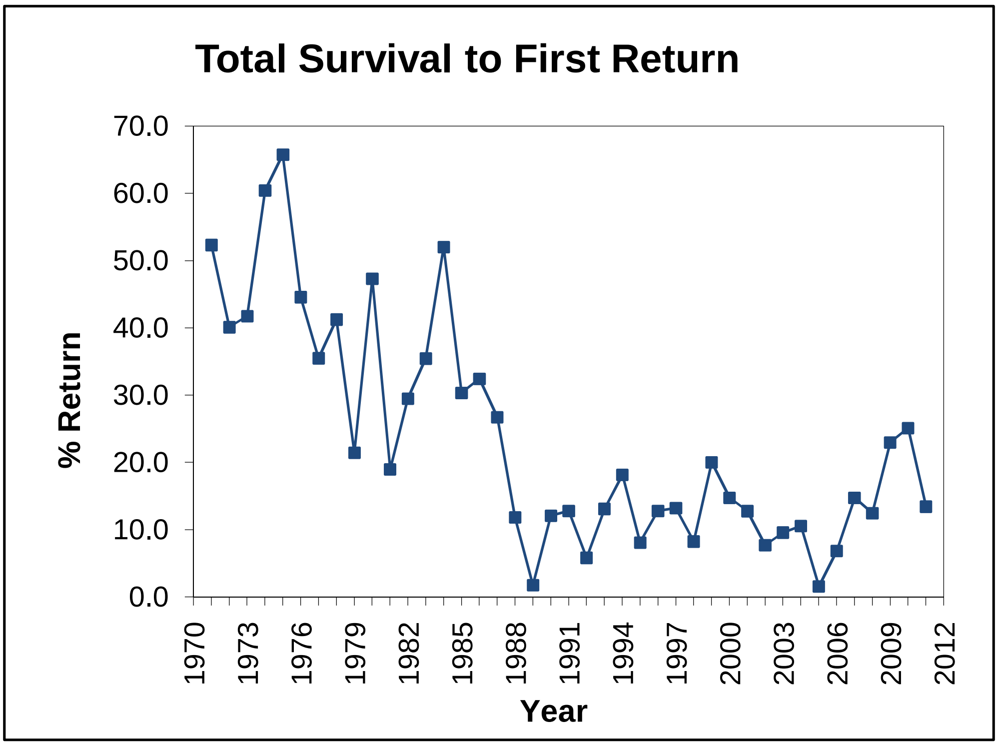


Figure 6-4: Annual marine survival of smolts to first return (as finnock and 1+ sea trout) to the Burrishoole system.

6.7 Sea Trout Kelts

Table 6.10 gives the numbers of sea trout and brown trout kelts, both spawned and immature, counted downstream in the winter of 2011 and spring of 2012.

The freshwater survival of kelts is given in Table 6.11. In some years, the number of kelts migrating downstream has exceeded the number of upstream migrants. This occurred in the early '80s when the screen allowed finnock to escape. This was rectified. More recently, the difficulty in separating small finnock and large smolts has led once again to a discrepancy as shown in Table 6.11. In addition to the size overlap, trout counted upstream as unsilvered migrants may be counted downstream as silvered kelts, and immature autumn downstream migrants may be misidentified as brown trout kelts, both causing additional difficulties in making survival estimates.

Since 1987, only one survival rate has been given for all sizes as it has been shown that a proportion (at least 33%) of the sea trout population may over-winter in freshwater. These fish do not spawn and continue to grow. There is also the additional complication of larger smolts and reduced sea growth mentioned above. Thus the comparisons of the proportion of fish in different year classes between the upstream migrants of one year and the downstream migrants of the next are invalidated.

In 2011/12, sea trout kelt survival increased to 117.5% and for finnock (small sea trout) it was 106%.

Table 6-10: Timing and numbers of sea trout kelts for the 2011/2012 season.

Month	Large ST	Small ST	BT	Total ST	Total Trout
October '11	4	1	17	5	22
November	4	8	51	12	63
December	5	3	63	8	71
January '12	7	3	16	10	26
February	5	13	20	18	38
March	0	7	2	7	9
April	2	18	0	20	20
May	0	0	1	0	1
June	0	0	1	0	1
Total	27	53	171	80	251

Table 6-11: Annual survival rate to sea trout kelt, as % of the upstream escapement of the previous year.

Year	Larger (> 30.0 cm)	Small (< 30.0 cm)	Year	Larger (> 30.0 cm)	Small (< 30.0 cm)
1976	79	66	1995	96.20%	“ *
1977	63	45	1996	127.70%	" *
1978	50	66	1997	97.00%	" *
1979	33	107*	1998	140.10%	" *
1980	50	82	1999	110.40%	" *
1981	44	345*	2000	70.10%	"
1982	53	203*	2001	82.00%	" *
1983	63	177*	2002	129.60%	" *
1984	74	210*	2003	66.10%	"
1985	70	98	2004	120.50%	"*
1986	66	72	2005	142.20%	"*
1987	58.7%	(combined)	2006	110.50%	"
1988	65.50%	"	2007	228.90%	"**
1989	68.70%	"	2008	98.90%	"**
1990	79.00%	" *	2009	107.50%	"*
1991	98.70%	" *	2010	59.40%	"
1992	89.50%	" *	2011	88.90%	"*
1993	96.70%	" *	2012	117.65%	"*
1994	104.60%	" *			

* Years when the number of finnock kelts counted downstream exceeded the number counted upstream during the previous season.

7 Silver Eel Census Programme

7.1 Numbers

Silver eel trapping was continued in 2012. The main run occurred in September, November and less so in October (Table 7.1). Almost half of the run was complete by the end of September and the run dropped off after November with only sixteen eels recorded in December. Figure 7.1 shows the daily counts of silver eels.

The total run amounted to 3335 eels. As in other years, the highest proportion of the total catch (78%) was made in the Salmon Leap trap.

The Mill Race was blocked and dried by a dam inserted at the outflow from the lake to allow for renovations to be made on the fish traps in the Mill Race. The dam was inserted on the 15th May and removed on the 18th July 2012. It is not thought that this had any impact on the silver eel migration.

Table 7-1: Timing and numbers of the 2012 silver eel run.

	Salmon Leap	Mill Race	Total	%
June	27	Trap Closed	27	0.8
July	41	Trap Closed	41	1.2
August	258	53	311	9.3
September	933	248	1181	35.4
October	603	164	767	23.0
November	725	259	984	29.5
December	15	1	16	0.5
Jan. 2013	5	2	6	0.2
Feb. 2013	1	0	0	0.0
Total	2608	727	3335	

7.2 Size

Sampling of individual eels (n = 3317) gave an average length of 43.0cm (range: 28.4 – 101.1cm) and an average weight of 163.5g (Table 7.2). The length frequency distribution is presented in Figure 7.2 along with those for 2010 and 2011 for comparison.

Counts of silver eel between the years 1971 (when records began) and 1982 averaged 4,400, fell to 2,200 between 1983 and 1989 and increased again to above 3,000 in the '90s (Fig. 7.3). There was an above average count in 1995, possibly contributed to by the exceptionally warm summer. The count in 2001 of 3875 eel was the second highest recorded since 1982. The average weight of the eels in the samples has been steadily increasing from 95 g in the early 1970s to 216 g in both the 1990s and the 2000s (Fig. 7.3). The annual count and average weight in 2010 and 2011 were both below the mean for the last decade.

In 2012, the majority of the eel run was sampled (n=3317; 99.5%). The run increased from 1969 in 2011 to 3335 in 2012 and the average weight decreased from 180 to 163.5g. The sex ratio changed from 24% to 45% over the past five years. Male eels have remained the same length over the past 15 years (36cm) whereas the females have changed from 53cm (1997-2005) to 50cm (2008-2012) and they were 49.2cm in 2012.

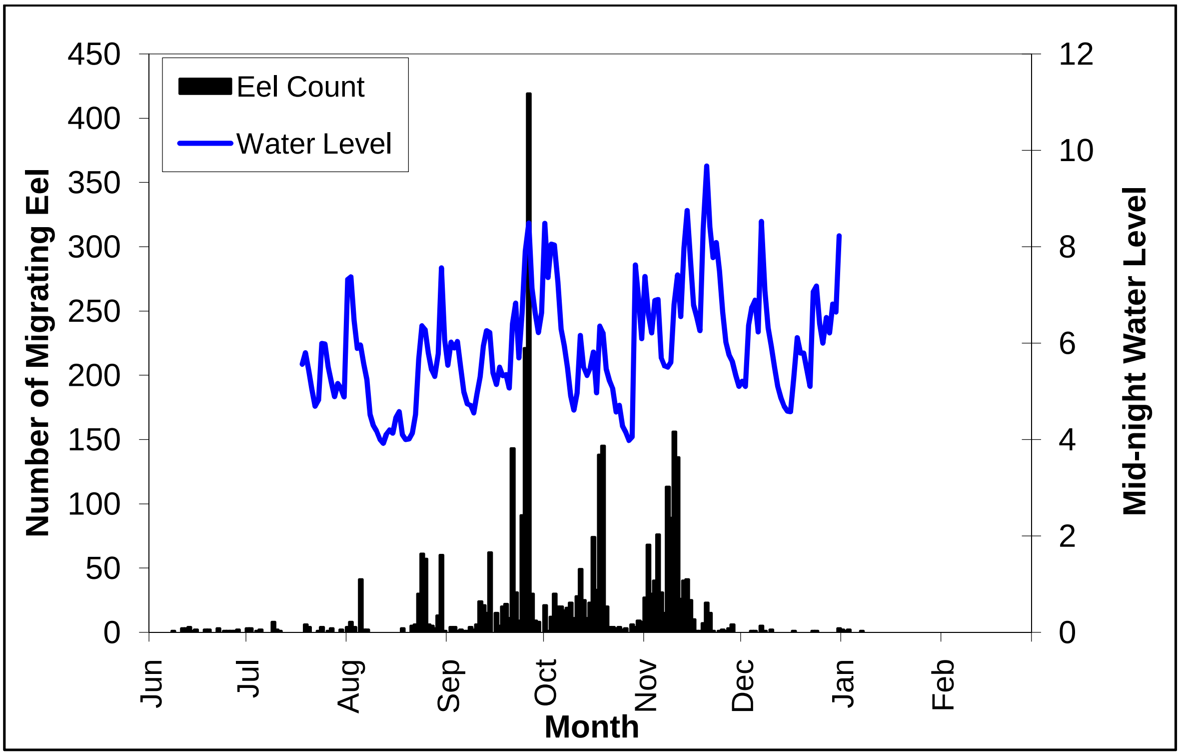


Figure 7-1: Daily counts of downstream migrating silver eel and mid-night water levels (m).

Table 7-2: Comparative data for the silver eel runs since 1971.

Years	Number Sampled	Mean. Weight (gm)
1971 - '75	4465	84
1976 - '80	4023	115
1981 - '85	2678	171
1986 - '90	11658	196
1991 - '95	3441	227
1996 - '00	3958	212
2001	850	238
2002	732	207
2003	650	177
2004	382	216
2005	587	237
2006	493	225
2007	571	201
2008	796	234
2009	220	209
2010	982	192
2011	1835	180
2012	3317	163

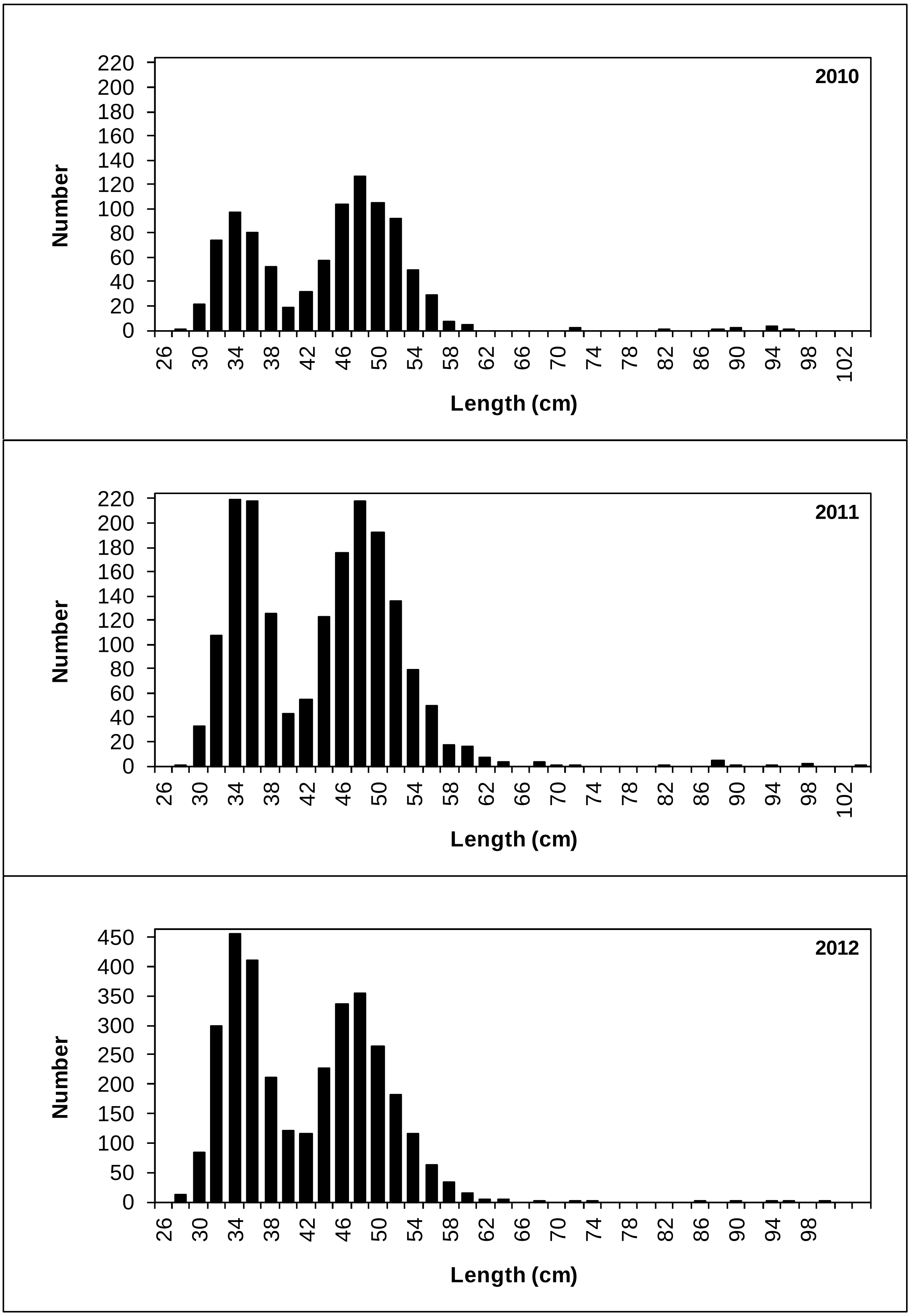


Figure 7-2: Length frequency of sub-samples of silver eels trapped in the downstream traps, 2010 (n=960), 2011 (n = 1835) and 2012 (n=3317). Note change of y-axis scale in 2012.

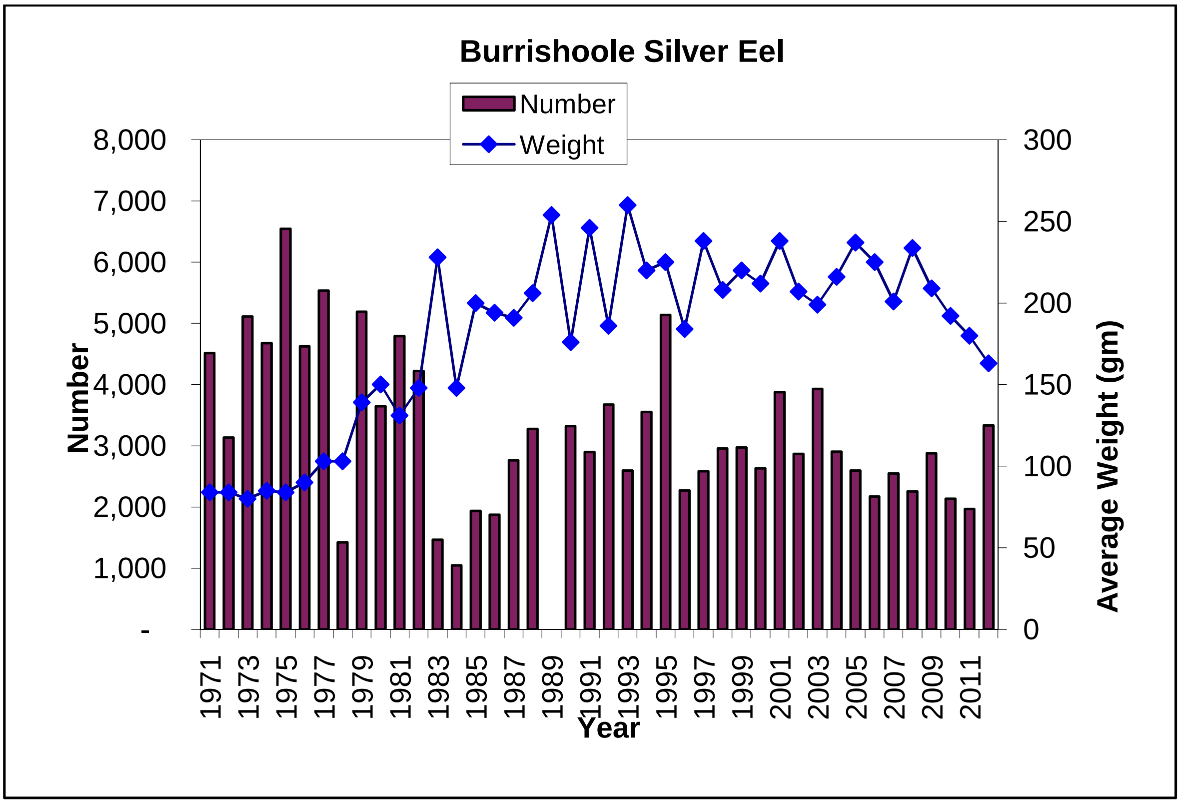


Figure 7-3: Annual number and mean weight of silver eels trapped in the downstream traps.

8 Fishery Report - Catch Data

The Burrishoole Fishery is a valuable part of the overall stock census programme and is run as an integral part of the monitoring programme. As part of the conservation of the Burrishoole wild stock, changes to the active season and to the parts of the catchment being fished have caused differences, or gaps, in the data being collected. Lough Feeagh, which had been closed to angling since 1997 for conservation reasons was opened to angling for the month of September in 2008, on a catch and release basis for wild fish. In 2009- 2012 Lough Feeagh was open for angling on a catch and release basis from August to the end of September.

During 2012 Lough Furnace was open to angling from 16th of June to the 30th September and Lough Feeagh from July 19th to September 30th. The fishery was operated on a 5 day week from Wednesday to Sunday inclusive and on a catch and release basis for wild fish.

8.1 Numbers and Average weight of Rod Catch

The Lough Furnace rod catch in 2012 consisted of 22 wild fish and 75 reared fish and the Lough Feeagh catch of 28 wild fish and 3 reared fish. All wild caught fish were returned alive.

The average weight of reared fish was 1.7kg (n = 75) and the heaviest fish was 2.4kg. No lengths or weights are available for wild fish due to catch & release being in place.

A total of 10 sea trout were caught on Lough Furnace and 5 sea trout on Lough Feeagh. Regulations remained in place whereby all rod caught sea trout were returned alive.

In addition to the sea trout caught on Lough Feeagh, a total of 788 brown trout were also caught on the lough.

8.2 Timing of Catch and Rod Effort

The highest monthly catch of both wild and ranched salmon on Lough Furnace was in June indicating that fish were returning to home waters early in the season. This is similar to the findings in the upstream traps where the June upstream migration of wild grilse in 2012 was 29.8% compared to 16.8% in 2011 and 0.9% in 2010.

The very wet conditions during the fishing season resulted in favourable conditions for fish to migrate upstream into Lough Feeagh. In addition the Mill Race channel was dammed during the summer for repairs to the trapping facilities and resulted in an increase in flow through the Salmon Leap.

Rod effort on Lough Furnace was lower by approx 25% in 2012 to that in 2011 and was double in 2012 compared to 2011 on L. Feeagh. This may reflect the change in return patterns of the fish as well as responding management of the fishery to run timing and numbers of available fish.

Table 8-1: Wild and reared salmon rod catch and rod effort (hours) for the 2012 season for L. Furnace and L. Feeagh.

Furnace

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	12	39	161
July	8	35	519
August	2	1	102
September	0	0	27
Total	22	75	809

Feeagh

	Salmon Catch		Effort in hours
	Wild	Reared	
May	0	0	0
June	0	0	0
July	0	0	0
August	18	1	148
September	10	2	77
Total	28	3	225

8.3 Exploitation Rates of Rod Fishery

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2011 are shown in Table 8.2. From 1997 onwards Lough Feeagh was closed to angling. Exploitation rates are only available for Lough Furnace since 1997. The cessation of angling on Lough Feeagh was due to the continuing low stock level of wild fish. Following the cessation of drift netting in 2007 and the increased return of wild fish it was decided to re-open Lough Feeagh in 2008 to angling for the month of September only on a catch and release basis for both wild and ranched fish. Since 2008, and in future years, the running of a fishery on L. Feeagh was reviewed each year and was dependent on sufficient wild stock being present.

No sea trout angling has been permitted on L. Feeagh since 1997.

Anglers fishing on Lough Furnace were requested to return wild fish alive to the water. Injured or damaged wild fish were permitted to be retained; therefore, the rod catch on Lough Furnace consists of a total catch which includes released fish and a retained catch which are fish that have been killed.

Rod exploitation rates for Lough Furnace and Lough Feeagh from 2003 to 2012 are shown in Table 8.2.

Table 8-2: Rod fishing exploitation rates (2002-2012).

	2004	2005	2006	2007	2008	2009	2010	2011	2012
WILD SALMON									
Lough Feeagh									
"Available" fish by end of fishing season	*	*	*	*	531	585	691	516	683
Total rod catch					18	5	8	13	28
Rod catch retained					0	0	0	0	0
Angling success %[1]					3	0.85	1.15	2.5	4.10
Exploitation rate %[2]					0	0	0	0	0
WILD SALMON	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Loughs Feeagh & Furnace									
Total stock of wild fish	610	542	566	1063	572	587	703	571	686
+ 10% addition for									
L. Furnace population	671	596	623	1169	629	646	773	628	755
Total catch of wild fish	10	27	48	26	52	12	26	36	50
Rod catch retained		1	5	2	1	1	0	0	0
Max. angling success %	1.6	5.0	8.5	2.4	9.1	2	3.7	6.3	7.3
Min. exploitation rate	0.3	0.2	0.9	0.2	0.2	0.2	0	0	0
Max. exploitation rate	0.3	0.2	0.8	0.2	0.2	0.2	0	0	0
REARED SALMON	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Lough Feeagh									
"Available" fish by end of fishing season	*	*	*	*	98	115	130	125	128
Total rod catch					1	1	1	1	3
Rod catch retained					0	0	0	0	0
Angling success %[1]					1.0	0.9	0.8	0.8	1.5
Exploitation rate %[2]					0.0	0	0	0	0
Loughs Feeagh & Furnace									
Total stock	902	952	954	2624	1865	456	940	1293	2392
Total rod catch	64	28	66	169	116	7	79	86	78
Exploitation rate %	7.1	2.9	6.9	6.4	6.2	1.7	8.4	6.7	3.3
WILD SEA TROUT	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Lough Feeagh									
"Available" fish by end of fishing season	*	*	*	*	39	135	71	55	90
Rod catch					3	12	1	1	5
Exploitation rate %					0	0	0	0	0

8.4 Angling Success

Table 8.3 presents the Catch per unit effort (CPUE) which is the number of fish caught per rod day, and the Effort per unit catch (EUPC) which is the number of rod days it takes to catch a fish.

Table 8-3: Catch per unit effort (CPUE) and effort per unit catch (EPUC) for the Burrishoole Fishery based on a eight hour fishing day. Salmon includes both wild and reared.

	Lough Furnace				Lough Feeagh			
	Salmon		Sea Trout		Salmon		Sea Trout	
Year	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC	CPUE	EPUC
'80-'84	0.13	9.92	0.85	1.35	0.23	4.47	0.63	2.10
'85-'89	0.24	4.89	0.46	5.09	0.24	4.57	0.29	70.30
'90-'95	0.20	6.10	0.17	16.80	0.20	5.40	0.10	14.00
'96	0.22	4.40	0.10	10.50	0.83	1.20	0.30	2.90
'97	0.17	6.00	0.10	9.60	*	*	*	*
'98	0.44	2.30	0.08	13.20	*	*	*	*
'99	0.09	10.80	0.05	20.80	*	*	*	*
'00	0.30	3.31	0.06	16.50	*	*	*	*
‘01	0.15	6.70	0.12	8.40	*	*	*	*
’02	0.12	8.30	0.07	15.30	*	*	*	*
’03	0.13	7.60	0.06	17.70	*	*	*	*
’04	0.22	4.60	0.16	6.30	*	*	*	*
’05	0.26	3.80	0.08	13.00	*	*	*	*
’06	0.44	2.30	0.04	23.50	*	*	*	*
’07	0.49	2.10	0.14	6.90	*	*	*	*
’08	0.35	2.89	0.05	21.60	0.46	2.18	0.07	13.80
’09	0.18	5.66	0.24	4.09	0.21	4.75	0.42	2.38
’10	0.60	1.66	0.14	7.27	0.82	1.22	0.09	11.00
'11	0.68	1.47	0.35	2.80	1.06	0.95	0.08	13.10
’12	0.96	1.04	0.10	10.10	1.10	0.91	0.18	56.62

9 Collaborative Research Programmes

9.1 Beaufort Fish Population Genetics

MI Newport is committed to supporting a number of agreed projects that are facilitated and undertaken as part of the Beaufort Fish Population Genetics Programme. The Marine Research Award in Fish Population Genetics was granted by the former Department of Communications, Marine and Natural Resources to University College Cork and Queens University Belfast in June 2007.

The Newport facility has collaborated with the Beaufort genetics group on a number of key programmes:

(i) Evolutionary genomics: pedigree reconstruction in a 40 year salmon monitoring project to reveal the association within families between qualitative and quantitative variation, and its contribution to population fitness. Collaborating Institutes: University of Turku, Finland (Prof. Craig Primmer); Beaufort Marine Research Award in Fish Population Genetics; Marine Institute.

The Burrishoole system offers a unique opportunity for reconstructing multigenerational pedigrees because of the intensive sampling of the population over four decades and the associated ecological and environmental information available. Pedigree based analysis is a powerful method for separating genetic effects from environmental effects on the phenotype, as demonstrated by their common use in domestic animal breeding programmes. However, pedigrees in the wild have rarely been constructed in any vertebrate especially fish, because of the logistical and technical difficulties in identifying and following the performance of individual families. Due to recent technological and analytical advances, combined with the sequencing of the salmon genome, salmon now provide a unique opportunity for study because of their fecundity, large family size and extensive information on ecology of the species.

To date, scale samples have been provided from selected year classes of adult salmon (1977 – 2009) and swab samples have been collected from contemporary populations since 2011. Genetic and statistical analysis for the salmon pedigree programme is being carried out by the University of Turku, funded by the Finnish Academy of Sciences.

(ii) Local adaptation in Atlantic salmon (*Salmo salar*)

A series of work programmes are in progress, which aim to determine the scale of biologically important local adaptation at small geographical scales, in Atlantic salmon and brown trout, using a common garden experimental approach:

- **i.** To assess the importance of local adaptation at small geographical scales by comparing the relative fitness of the progeny of Burrishoole and Owenmore Atlantic salmon parents and their reciprocal hybrids in a common natural environment (Partners: MI Newport , Beaufort Ph.D. studentship UCC).

- **ii.** The establishment of a common garden experiment in the Srahrevagh (Burrishoole) and Tawnyard (Erriff) experimental rivers for the study of local adaptation in Atlantic salmon (Partners: MI Newport, WRFB, Beaufort Group).

iii. To assess the importance of local adaptation at small geographical scales by comparing the relative fitness of the progeny of Burrishoole and Bunaveela brown trout parents and their reciprocal hybrids in a common natural environment (Partners: MI Newport, Beaufort Group).

Trapping facilities on the Rough River were serviced on a daily basis from March 2009 and fish in the downstream traps were recorded and sampled according to protocol. Salmon smolts (2+) collected in spring 2011 and 2012 marked the end of the freshwater component for these studies and genotyping and assignment of fish samples is ongoing. Traps were re-opened in November 2012 for collection of wild salmon moving upstream and sampling of downstream migrants (predominantly trout) from November 2012 to January 2013.

The Institute has facilitated a number of other projects in collaboration with the Beaufort Group by way of providing samples to support a number of research projects in Queens University Belfast and University College Cork. Collaborative project titles include:

Beaufort Trout MicroPlex: a high throughput multiplex platform comprising 38 informative microsatellite loci for use in brown trout and sea trout (*Salmo trutta* L.) population genetics studies

Using genetic stock identification to elucidate the biology and ecology of the brown trout/sea trout (*Salmo trutta*) population complex in the Burrishoole system, west of Ireland

Patterns of variation in adaptive traits and neutral markers across a three-spine stickleback (*Gasterosteus aculeatus*) freshwater-anadromous hybrid zone

Local adaptation in Atlantic salmon (*Salmo salar*): seeking empirical evidence within a common garden experimental framework (the Owenmore experiment)

Local adaptation in Atlantic salmon (*Salmo salar*): seeking evidence within a reciprocal transfer common garden experimental framework (the Erriff experiment)

Local adaptation in brown trout (*Salmo trutta*): seeking evidence within a common garden experimental framework (the Bunaveela experiment)

Evolutionary genomics: pedigree reconstruction in a 40 year salmon monitoring project to reveal the association within families between qualitative and quantitative variation, and its contribution to population fitness

Clock gene variation: insight into qualitative variation underlying run timing and sea age in Atlantic salmon (*Salmo salar*)

Assessing the V-notching as viable tool for the conservation and long term sustainability of European lobster (*Homarus gammarus*) stocks

Parallel phenotypic response of Atlantic salmon *Salmo salar* and brown trout *Salmo trutta* to different river environments

9.2 Prevent Escape

The Prevent Escape project (2009-2012) is a research project funded by the European Community under FP7. Escapes of fish from sea-cages have been reported for almost all major species cultured across Europe, including Atlantic salmon, sea bream, sea bass, Atlantic cod and rainbow trout. The project is specifically designed to conduct and integrate biological and technological research on a pan-European scale to improve recommendations and guidelines for aquaculture technologies and operational strategies that reduce escape events. Prevent Escape involves 11 partners from six countries (Norway, Greece, Spain, Malta, Scotland and Ireland) and is led by SINTEF Fisheries and Aquaculture. The Marine Institute are involved in two work packages and as project leaders for Map Escape, are responsible for carrying out a Europe wide survey of escape events and their causes

9.3 Lakes Studies

Palaeolimnological assessment of recent ecosystem disturbance / regime shifts in sediment cores from ecotonal brackish lake systems

Filippo Cassina from Mary Immaculate College, Limerick, commenced the fourth year of his PhD Study *'Palaeolimnological assessment of recent ecosystem disturbance / regime shifts in sediment cores from ecotonal brackish lake systems'*. The aim of this EPA funded fellowship is to examine the recent palaeolimnology of two brackish lake systems, one of which is Lough Furnace. Specifically the project is quantifing the salinity and nutrient response in the fossil diatom, cladoceran and foraminifera records. These results were supplemented by quantification of the organic isotope ratio (C:N) in the sediment record in an effort to establish changes in allochthonous and authochonous sediment inputs. Filippo submitted his thesis in 2012.

Limno- and palaeo- limnological responses to lake water dissolved organic carbon (DOC)

This PhD study, funded by the EPA, was carried out by Karin Sparber of Mary Immaculate College Limerick, under the supervision of Dr. Catherine Dalton. This project provides a clearer understanding of the special features of dystrophic (nutrient poor) lake waters through quantification of the response in bacterial and algal populations of Lough Feeagh. Karin submitted her thesis in 2012.

Estimating carbon pools and processing in a humic Irish lake.

Traditional models of production in lakes emphasise the importance of phytoplankton as a source of energy to the open-water food web. However, in humic lakes, dissolved organic carbon (DOC) from the surrounding catchment, supplying the microbial portion of the food web, may be an equal or more important source of carbon. The aim of this PhD project by Liz Ryder, Dundalk IT, is to elucidate the role of these two carbon sources in fuelling production in a humic lake in the west of Ireland. The project will use a combination of high resolution fluorescence data available for both the phytoplankton and DOC pools, together with lower frequency sampling of the carbon pools in additional biological components, to quantify carbon availability and processing. The collated data will facilitate application and validation of models of in-lake productivity and an assessment of future climate impacts on carbon cycling using downscaled climate change data which are available specifically for the study site. These data, together with data available from other past and on-going projects, will also allow comparative assessment of primary and secondary production in this lake within the framework of a whole-lake carbon budget, both under present and future climate conditions. Liz is being jointly supervised by Dr Eleanor Jennings, who has worked on data from the Burrishoole catchment for many years, and Elvira de Eyto (MI). Work in 2012 included calibration of instruments, and zooplankton experiments to assess carbon uptake. A paper on temperature quenching of DOC was published.

9.4 SANIFAC

(from Liwen Xiao)

It was estimated that about 500,000 ha of peatland was afforested between the 1950s and 1990s in the UK and 300,000 ha in Ireland. Many of these blanket peat forests are now reaching harvestable age and concerns have been raised about the potential release of nutrients to the receiving aquatic systems as a result of harvesting. These areas contain the headwaters of rivers, many of which contain Red List species (e.g. salmonids and freshwater pearl mussels) which make them important biodiversity refuges. Despite the fact that the sensitivity of clearfelling upland peat catchments has risen to prominence in recent years in terms of economic and conservational viability, sustainable protection methods are poorly researched and proven. The objectives of this study were to investigate the impacts of forestry clearfelling on the ecology and flow regime of receiving water and to assess the performance of buffer zones, phased felling, brash removal and the novel grass seeding method on ameliorating any negative clearfelling impacts.

In order to quantify the effects on the water quality, two sub-catchments were closely monitored in the two years pre- and post-harvesting and hydrological, physical, chemical and biological parametric data such as rainfall, stream flow rate, pH, temperature, DO, conductivities, phosphorus (P), nitrogen (N), suspended solids (SS), macroinvertebrates and diatoms have been collected intensively. The results indicated that, even with the implementation of the best management practices, peatland forest harvesting activities could (1) have no significant impact on SS concentration in the receiving water; (2) increase catchment water yield but not increase flood risk; (3) increase P and N concentrations in the study streams; and (4) affect the macro-invertebrate and diatom assemblages in the rivers.

Buffer zones (BZs) have been recommended internationally as a mitigation measure for tackling pollution sources and transport. However, large areas of upland blanket peat were afforested in the UK and Ireland before the importance of the riparian buffer areas was realized. In order to reduce the possible negative impact of harvesting activities on receiving water bodies, the creation of buffer areas along receiving water courses prior to the clear-felling of the main plantation has been proposed. In this study, a small buffer zone with the effective area of about 0.1 ha was established and seeded with native grass species and the runoff from the upstream forest with area of about 10 ha was spread to the buffer zone. One year later, the upstream forest was harvested. The result indicated that the buffer zone removed 45.3%, 33.7% and 17.6% of the suspended solid (SS), total oxidised nitrogen (TON) and PO_4-P, respectively, in the first year of harvesting.

To reduce nutrients leaching from forest catchment to water, a novel practice – grass seeding clearfelled areas immediately after harvesting – was proposed in this study. It was hypothesized that if the vegetation could quickly recover after forest harvesting, the nutrients would be retained *in situ* through vegetation uptake. A field trial was carried out to identify the successful native grass species that could grow quickly in the blanket peat forest. The two successful grass species - *Holcus lanatus* and *Agrostis capillaris* – were sown in three blanket peat forest study plots with areas of 100 m^2, 360 m^2 and 660 m^2 immediately after harvesting. Areas without grass seeding were used as controls. One year later, the P content in the above ground vegetation biomass of the three study plots were 2.83 kg P ha^{-1}, 0.65 kg P ha^{-1} and 3.07 kg P ha^{-1}, respectively, which were significantly higher than the value of 0.02 kg P ha^{-1} in the control areas. The water extractable phosphorus (WEP) in the three study plots were 8.44 mg (kg dry soil)$^{-1}$, 9.83 mg (kg dry soil)$^{-1}$ and 6.04 mg (kg dry soil)$^{-1}$, respectively, which were lower than the value of 25.72 mg (kg dry soil) $^{-1}$ in the control sites. The results indicate that grass seeding of the peatland immediately after harvesting can quickly immobilize significant amounts of P and warrants additional research as a new Best Management Practice following harvesting in the blanket peatland forest to mitigate P release.

To further examine the grass seeding practice, experimental plots with defined boundary conditions were established. In addition, other mitigation approaches such as whole tree harvesting were also tested by using plots. In these plots, three sets of five treatments were compared as follows: 1) no brash and no seeded grass, 2) brash without seeded grass, 3) brash with seeded grass 4) seeded grass only, 5) brash removed after 6 months. The results indicated that (1) brash mat was significant nutrients release sources; (2) whole tree harvesting could significantly reduce nutrients release and (3) grass seeding could be a sustainable practice for nutrient release control after forest harvesting.

SANIFAC mainly focused on the assessment and mitigation of soil and nutrient losses from acid-sensitive forest catchments. Dr. Michael Rodgers was the original Principal Investigator. After his retirement at the end of November 2009, Professor Padraic O'Donoghue took over the PI role. Dr. Liwen Xiao (NUIG) was the project co-ordinator and research fellow. Mr. Mark O'Connor was the research assistant in NUIG-Burishoole. Connie O'Driscoll (NUIG-Burrishoole) and Zaki-ul-Zaman Asam (NUIG) were the two postgraduate students. The field study of this project is carried out in four sub-catchments in Burrishoole Catchment. This project was completed in 2012 and two PhDs were awarded.

9.5 HYDROFOR

(from Mark Healy, NUIG)

HYDROFOR was funded by the Environmental Protection Agency's STRIVE fund for UCD, UCC and NUIG to work on six catchments (3 in higher details than others) for 5 years commencing on 1/5/2008 and will end on 30/4/2013. The NUIG component of the work was based in Burrishoole, Newport. Dr. Mark Healy was the project co-ordinator and Mr. Mark O'Connor the research assistant (funded through SANIFAC). John Regan was a Research Assistant and Joanne Finnegan was the postgraduate student.

The HYDROFOR project compared nutrient and sediment release from forest clearfelling operations. Two sites are being examined: (1) in Glenamong, sediment and nutrient release from two 8-ha sites (a study site and a control site) are being examined; (2) in Altahoney, the effectiveness of naturally revegetated riparian buffer zones - clearfelled in 2006 – in mitigating the particulate and nutrient releases from forest harvesting activities upslope (which took place in January/February, 2011) are also being investigated.

The Glenamong site comprises a study and a control site. Each site was fully instrumented with an H-Flume for measuring the flow and a data-sonde for measuring pH, temperature, conductivity and dissolved oxygen. Prior to and subsequent to clearfelling of the study site, which took place in January – February 2011, baseline and storm flow measurements of water volumes draining the catchment and water quality have been conducted. Suspended sediment release peaked to a daily flow weighted mean concentration of approximately 100 mg/L during clearfelling, but, following the installation of sediment traps, reduced considerably to concentrations just above the pre-clearfelling values. Soluble reactive phosphorus (SRP) concentration has increased gradually subsequent to clearfelling and was monitored during storm events.

The second study site was located in the Altahoney forest in the Burrishoole catchment in Co. Mayo. This catchment is situated in the Nephin Beg range at an approximate elevation of 150 m above sea level. In January-March 2011, approximately 2 ha of forest in Altahoney was clearfelled. A buffer zone - clearfelled in 2006 – is in place to capture nutrients and sediment from the clearfelled site. The site is reasonably well vegetated and was instrumented with piezometers to monitor water table changes and sampling tubes to enable subsurface water samples to be collected and analysed. Each sampling location comprised a set of 3 sampling tubes, positioned at 20 cm, 50 cm and 100-cm-depths below the surface. Water samples were collected at these points (approximately once a month). The site was also instrumented with time domain reflectrometry

(TDR) probes to measure soil water content, and the standing forest and revegetated buffer areas were also instrumented with greenhouse gas measurement facilities.

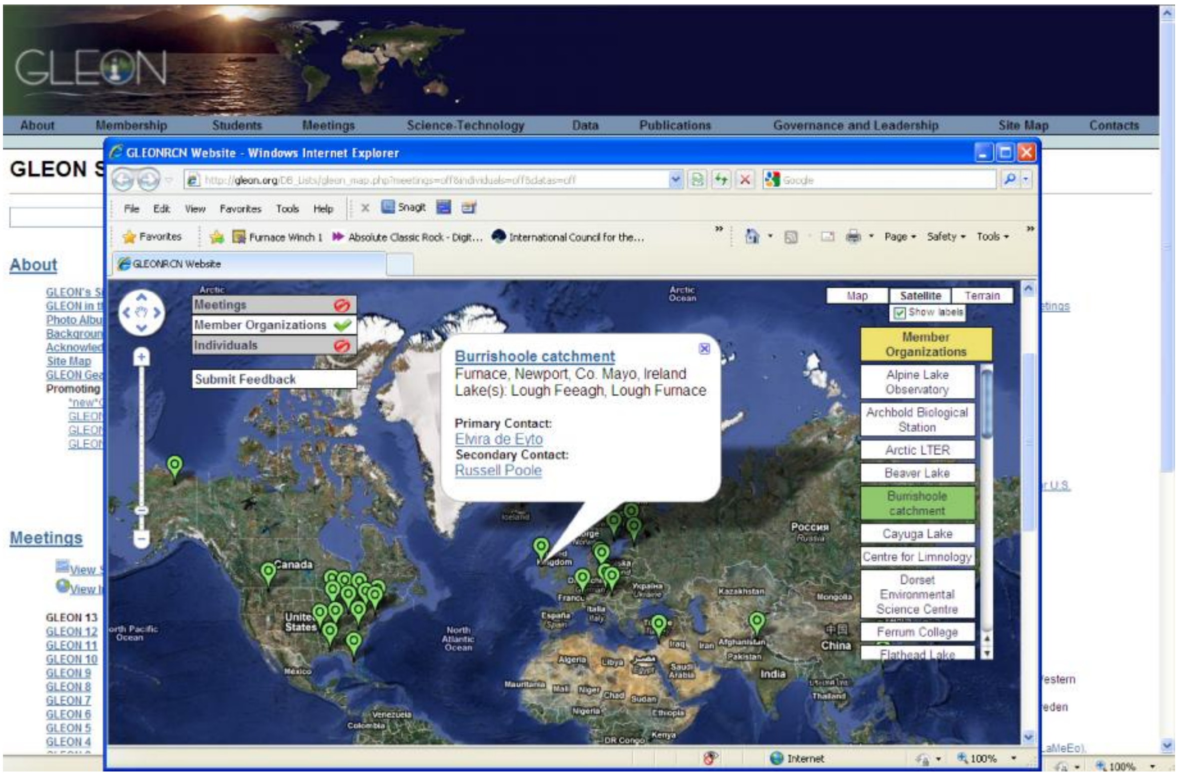
In August 2011, a survey was carried out to determine the percentage survival and increase in growth of the saplings, depending on the current height and existence of the tree, to determine which tree species best suited the peatland buffer environment. Water extractable phosphorus (WEP) and desorption-sorption isotherm testing was also carried out on samples of the soil from the regenerated buffer area and the adjacent mature standing forest. For both tests, a series of sampling points were selected in three transects parallel to the river in the regenerated buffer area at the following locations: (1) 1 m from the river (2) under the brash mat approximately 35 m from the river, and (3) under a vegetated area in-between brash mats approximately 45 m from the river. Soil samples were also collected (using a completely randomized block design) from the mature standing forest to represent the contributing area.

Inverse Distance Weighted (IDW) images, generated from the subsurface SRP concentrations, show the comparison of the regenerated buffer zone with the standing forest. Higher nutrient concentration was observed under the decaying brash mats in the buffer zone, which were left on site five years before the present study. The SRP concentration reduced close to the river edge due to the adsorption capacity of the mineral peat layers near the river.

The project went to schedule and testing was completed by July/August 2012. The PhD student completed and submitted in 2012. Water sampling is being conducted at site during flood events. The final round of WEP testing of soil samples is currently being conducted. The greenhouse gas measurement study is complete and pre- and post-clearfell data is being analysed.

9.6 GLEON

The Burrishoole Catchment is now a member of GLEON – a grassroots network of limnologists, ecologists, information technology experts, and engineers who have a common goal of building a scalable, persistent network of lake ecology observatories worldwide. The GLEON network currently includes 28 major lake sites worldwide, where remote high frequency monitoring of lake ecosystems is taking place (see www.gleon.org). The Institute has been represented at the last 6 GLEON meetings by either Liz Ryder or Elvira de Eyto. One GLEON meeting took place in 2012 - GLEON14 which was held in Mulranny, Ireland, in October and was attended by Elvira de Eyto, Mary Dillane, Russell Poole and Liz Ryder (DkIT). GLEON14 was co-hosted by The Marine Institute and Dundalk IT and the opening address was given by Dr. Peter Heffernan. In excess of 130 international Scientists and water managers attended this meeting which was a testament to the work being done by the Marine Institute in this area. The Institute hosted a field day in Burrishoole with almost 100 delegates attending the activities.



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10 Catchment Stock Assessment

10.1 Introduction

The Burrishoole catchment, upstream of the main fish traps, has been monitored since 1990 with surveys of the salmonid and eels stocks taking place in the rivers and the main lakes. Electrofishing, with 3-fishing depletions, is used for salmonids and eels in the streams, fine mesh beach seines are used for salmonids in the lakes and summer fyke nets are used for eels in the lakes.

10.2 Electrofishing Surveys

2012 marked the completion of 22 years of electrofishing surveys in the Burrishoole and Owengarve catchments. Densities of juvenile salmonids were calculated using three pass removal sampling.

In 2012, in total 40 sites in the Burrishoole and Owengarve catchments were fished between the 4th August and the 6th September. A total of 2937 fish were caught and measured over the 40 sites. Summary data are presented in Figures 10.1-10.6, and these show the distribution of fish densities around the catchment for eel (Fig. 10.1), 0+ salmon (Fig. 10.2), 1+ salmon (Fig. 10.3), 0+ trout (Fig. 10.4), 1+ trout (Fig. 10.5) and 2+ trout (Fig. 10.6).

The average eel density was 0.01 fish/m^2, with eels recorded in 14 sites out of 40. Highest densities were recorded in the Owengarve river. Average density of 0+ salmon was 0.33fish/m^2, with catches recorded in 23 sites. Highest densities were recorded in the Goulaun and Rough rivers, where densities exceeded 1 fish fish/m^2. 1+ salmon were recorded in 24 sites, with an average density of 0.05 fish/m^2. Apart from one Goulaun site, other sites with a high density of 1+ salmon included the Fiddaunveela and the bottom site of the Maumaratta. Average densities of 0+, 1+ and 2+ trout were 1.51, 0.35 and 0.10 fish/m^2 respectively. 0+trout were recorded in all but two of the forty sites, while 1+ and 2+ trout were recorded in 32 and 27 sites respectively.

10.3 Beach Seine Surveys

Due to high water levels and poor weather conditions, beach seine surveys were not conducted in 2012.

10.4 Fyke Net Surveys

10.4.1 Survey Data

Fyke net surveys of yellow eels have been conducted in the 1970s and 1980s as parts of previous studies. The Burrishoole lakes Feeagh and Bunaveela have been incorporated into the National Eel Survey in 2009-2012. Fyke net surveys of the tidal Lough Furnace and 'Back of the House' have been more sporadic or at a lower effort.

Yellow-eel stock monitoring is integral to gaining an understanding of the current status of local stocks and for informing models of escapement. Such monitoring also provides a means of evaluating post-management changes and forecasting the effects of these changes on silver eel escapement. The monitoring strategy aims to determine, at a local scale, an estimate of relative stock density, the stock's length, age and sex profiles, and the proportion of each length class that migrate as silvers each year.

Fyke net surveys carried out between 1960 and 2008 will provide a useful bench mark against which to assess the changes in stock. The yellow eel monitoring strategy will rely on the use of standard fyke nets. Relative density will be established based on catch per unit (scientific-survey) effort.

Bunaveela Lough is located in the upper reaches of the catchment. It has a surface area of 42ha and a maximum depth of 23m. Bunaveela L. was fished in the traditional style in 2012 (24 July 2012), with chains of 10 nets fished at three sites (A, B, C). In total 13 eels were caught with a catch per unit of effort of 0.43. The eels ranged in length from 36.5cm to 53.4cm. All eels were PIT tagged.

Lough Feeagh has a surface area of 395ha and an average depth of 14.5m (with several areas >35m in depth). L. Feeagh was fished in the traditional style in 2012 (25-26 July 2012), with chains of 10 nets fished at six sites (A, C, D, E, F, J) for one night each. In total, 83 eels were caught with a catch per unit effort (CPUE) of 1.38 (Table 10.1). The eels average length was 40.8 cm and ranged in length from 30.2cm to 62.4cm, with a total weight of 10.455kgs caught for the two nights (Table 10.1). Most of the catch was PIT tagged and one previous recapture was taken.

Lough Furnace, the tidal lough, has a surface area of 125ha north of Nixon's Island and 16ha between Nixon's Island and the mouth of the estuarine river ('Back of the House'). The main lough has a maximum depth of 21.5m. Furnace is heavily stratified with significant areas of deoxygenated water in the main basin. L. Furnace was fished in the traditional style in 2012 (17-19 July 2012), with chains of 10 nets fished at six sites (A, B, C, D, E, F) in one night each and one night with two chains of nets at the Back of the House.. In total, 64 eels were caught.

In L. Furnace, 45 eels were caught with a catch per unit effort (CPUE) of 1.00 (Table 10.1). The eels average length was 41.5 cm and ranged in length from 31.4cm to 59.8cm, with a total weight of 5.975kgs caught for the 2 nights (Table 10.1).

In the Back of the House, 19 eels were caught with a catch per unit effort (CPUE) of 0.95 (Table 10.1). The eels average length was 43.0 cm and ranged in length from 33.3cm to 54.4cm, with a total weight of 2.655kgs caught (Table 10.1).

Table 10-1: Catch details of the yellow eel survey carried out in 2012.

Lake	Dates	No. Eels	Net* Nights	CPUE	Total weight (kg)	Mean length (cm)	Mean weight (Kg)
Feeagh	25/07/2012	44	30	1.5	4.53	38.4 (30.2-48.5)	
	26/07/2012	39	30	1.3	5.93	43.5 (32.2-62.4)	
	2012	**83**	**60**	**1.4**	**10.46**	**40.8 (30.2-62.4)**	**0.125**
Bunaveela	24/07/2012	13	30	0.4		42.7 (36.5-53.4)	
	2012	**13**	**30**	**0.4**		42.7 (36.5-53.4)	
Furnace	17/07/2012	17	30	0.6	2.00	40.2 (31.4-54.9)	
	18/07/2012	28	30	0.9	3.98	42.4 (32.3-59.8)	
	2012	**45**	**30**	**1.0**	**5.98**	**41.5 (31.4-59.8)**	**0.133**
BOH	19/07/2012	19	20	1.0		46.5 (33.9-72.5)	
	2012	**19**	**20**	**1.0**	**2.66**	**43.0 (33.3-54.4)**	**0.140**

* Net (pair of traps)

10.4.2 Anguillicoloides crassus

By Conor Dolan (JobBridge Intern)

Anguillicoloides crassus is an indigenous parasitic nematode of the Japanese eel *Anguilla japonica* in Asia. *A. crassus* does not cause serious pathological damage in its natural host. However, infections in European eel are potentially more serious and can cause damage to the swimbladder with associated bacterial damage, red and swollen anus, as well as, in most severe cases, the collapse of the swimbladder lumen.

A. crassus was introduced into Europe in the early 1980s and it has since spread widely and has successfully colonized most European countries. It was first recorded in Ireland (Waterford Harbour) in 1997. Later records came from the Erne catchment in 1998 and it is now present in approximately 74% of the wetted area of Ireland. The most likely infective route to Ireland was the commercial eel trade although localised spread can be through natural eel movements and paratenic hosts.

The Burrishoole catchment has remained free of the parasite until recently. In the fyke net survey in 2012, samples of yellow eels captured in L. Furnace (saline) and at the Back of the House (tidal lough below L. Furnace) were found to be infected with *A. crassus.* Samples of yellow eels from L. Feeagh were negative and a comprehensive sample of silver eels from the traps was also negative indicating that in 2012 the infection seemed to be confined to the tidal lough. This was somewhat surprising as a number of environmental factors have been shown to influence *A. crassus* infections. High salinity has been shown as having a negative impact in the egg hatching and larvae survival of the parasite although the effects of water salinity remain unclear as various surveys have shown no differences in infection levels in waters with different salinity values.

Examination of previous samples would indicate that the parasite was likely to have been introduced into L. Furnace in 2010 or early 2011 (Table 10.2). To date it has not been recorded in the freshwater catchment.

Table 10-2: Location and sample details for eels in Burrishoole examined for the presence of *Anguillicoloides crassus*.

Year	Location	No. of eels checked	Stage	No. Infected	Prevalence	Intensity
Freshwater						
2009	Traps	50	Silver	0	0	0
2010	Yellow R.	5	Yellow	0	0	0
2010	Black Lakes	3	Yellow	0	0	0
2010	Glenamong R.	3	Yellow	0	0	0
2010	Feeagh	2	Yellow	0	0	0
2010	Traps	17	Silver	0	0	0
2011	Traps	50	Silver	0	0	0
2011	Feeagh	30	Yellow	0	0	0
2012	Feeagh	4	Yellow	0	0	0
2012	Traps	168	Silver	0	0	0
Saline Water						
2008	Furnace	60	Yellow	0	0	0
2009	Fu Nixons Br.	47	Silver	0	0	0
2010	Furnace	10	Yellow	0	0	0
2010	Fu Nixons Br.	50	Silver	0	0	0
2011	Furnace	4	Yellow	2	50	1.0
2012	BOH	6	Yellow	6	100	2.0
2012	Furnace	10	Yellow	7	70	4.43

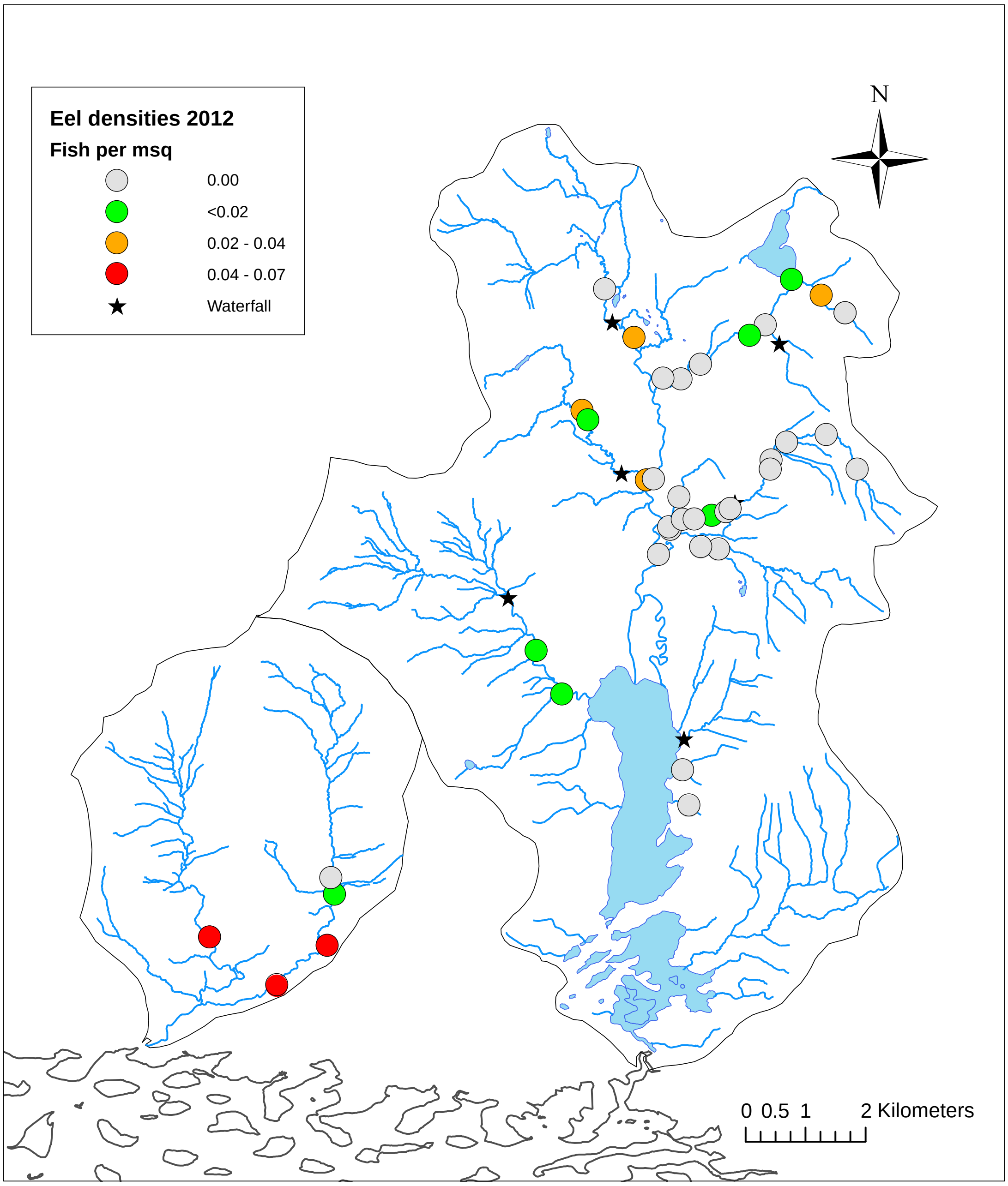

Figure 10-1: Densities of eel calculated from the 2012 electrofishing survey of the Burrishoole and Owengarve catchments.

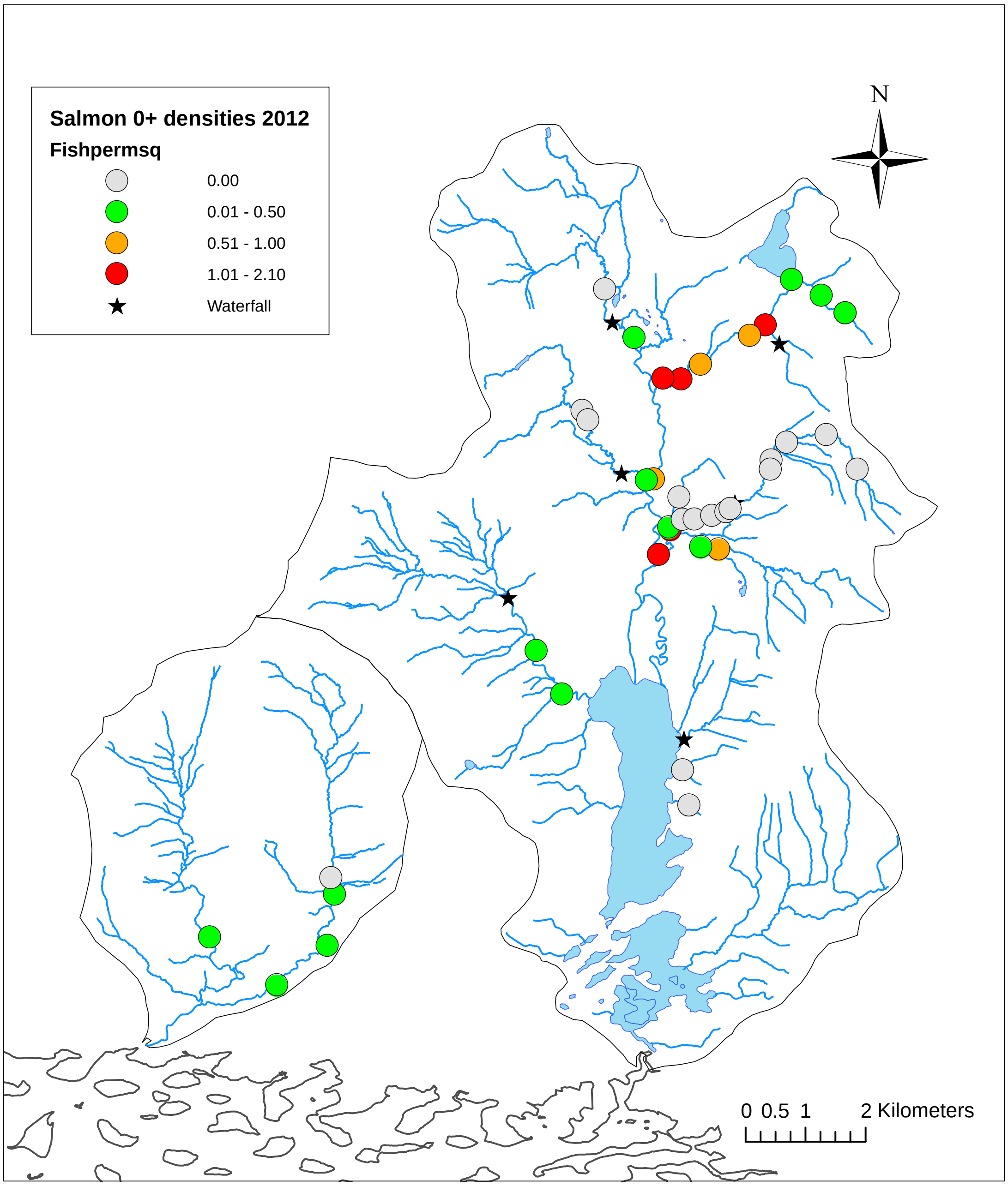

Figure 10-2: Densities of 0+ salmon calculated from the 2012 electrofishing survey of the Burrishoole and Owengarve catchments.

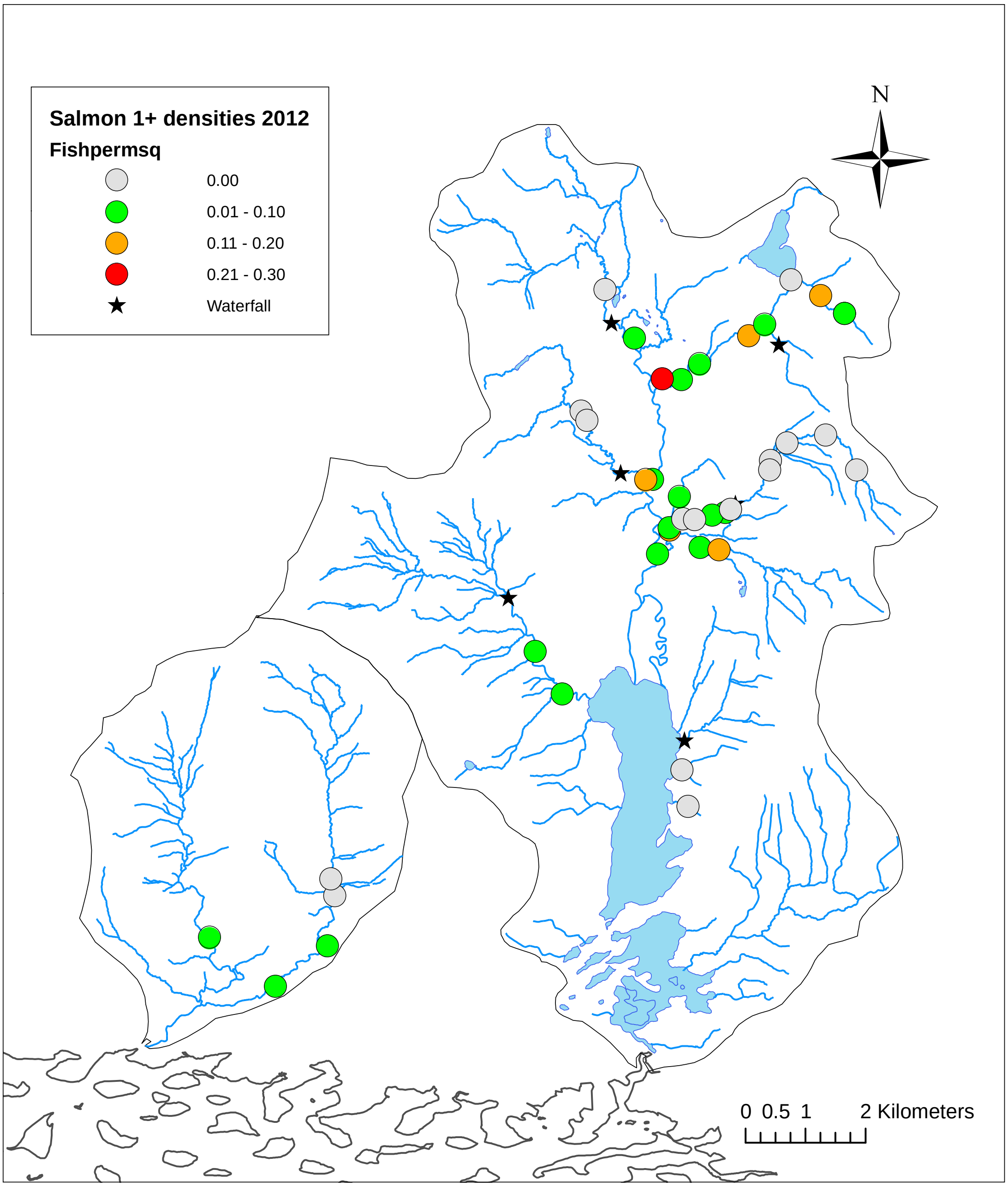

Figure 10-3: Densities of 1+ salmon calculated from the 2012 electrofishing survey of the Burrishoole and Owengarve catchments.

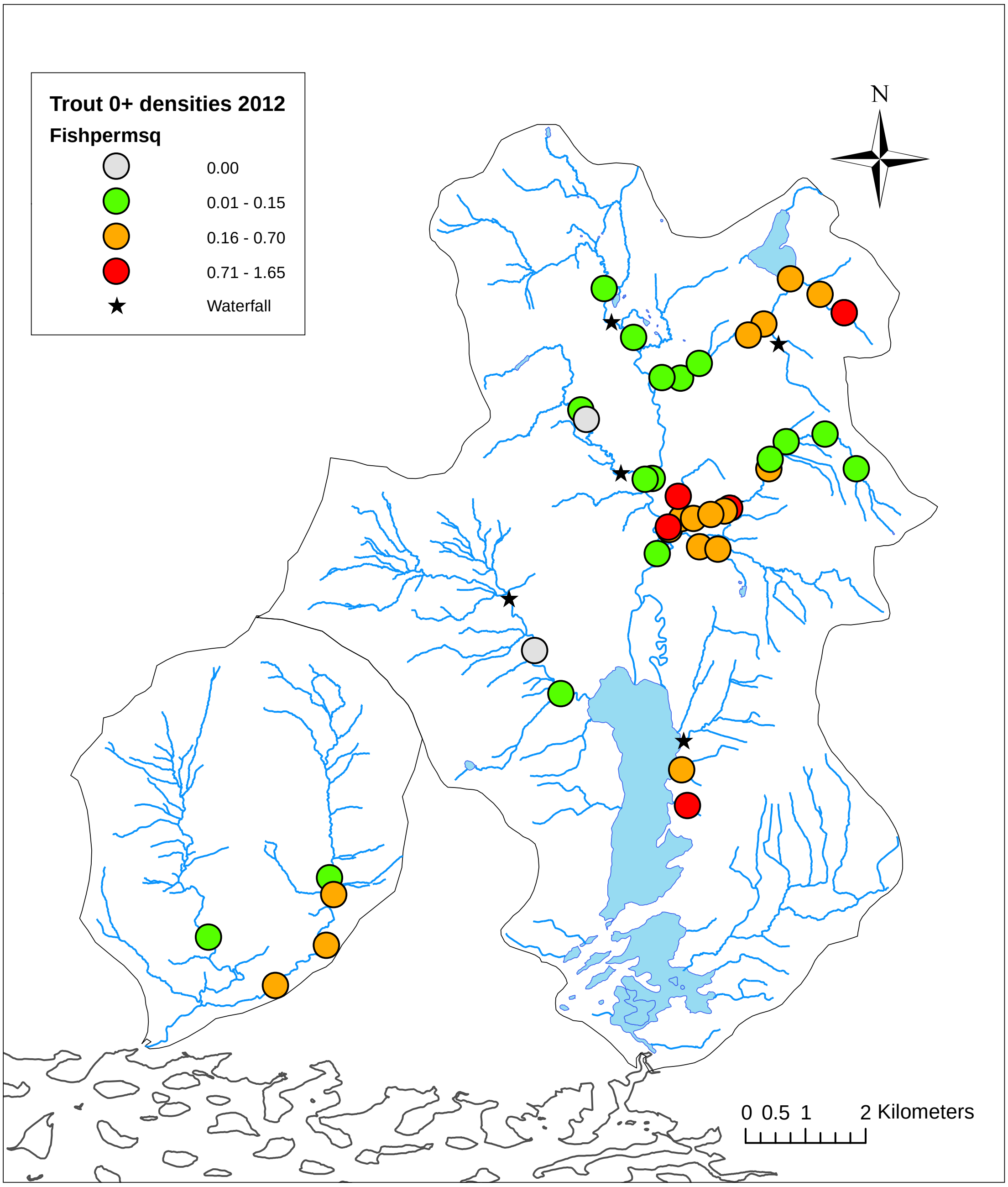

Figure 10-4: Densities of 0+ trout calculated from the 2012 electrofishing survey of the Burrishoole and Owengarve catchments.

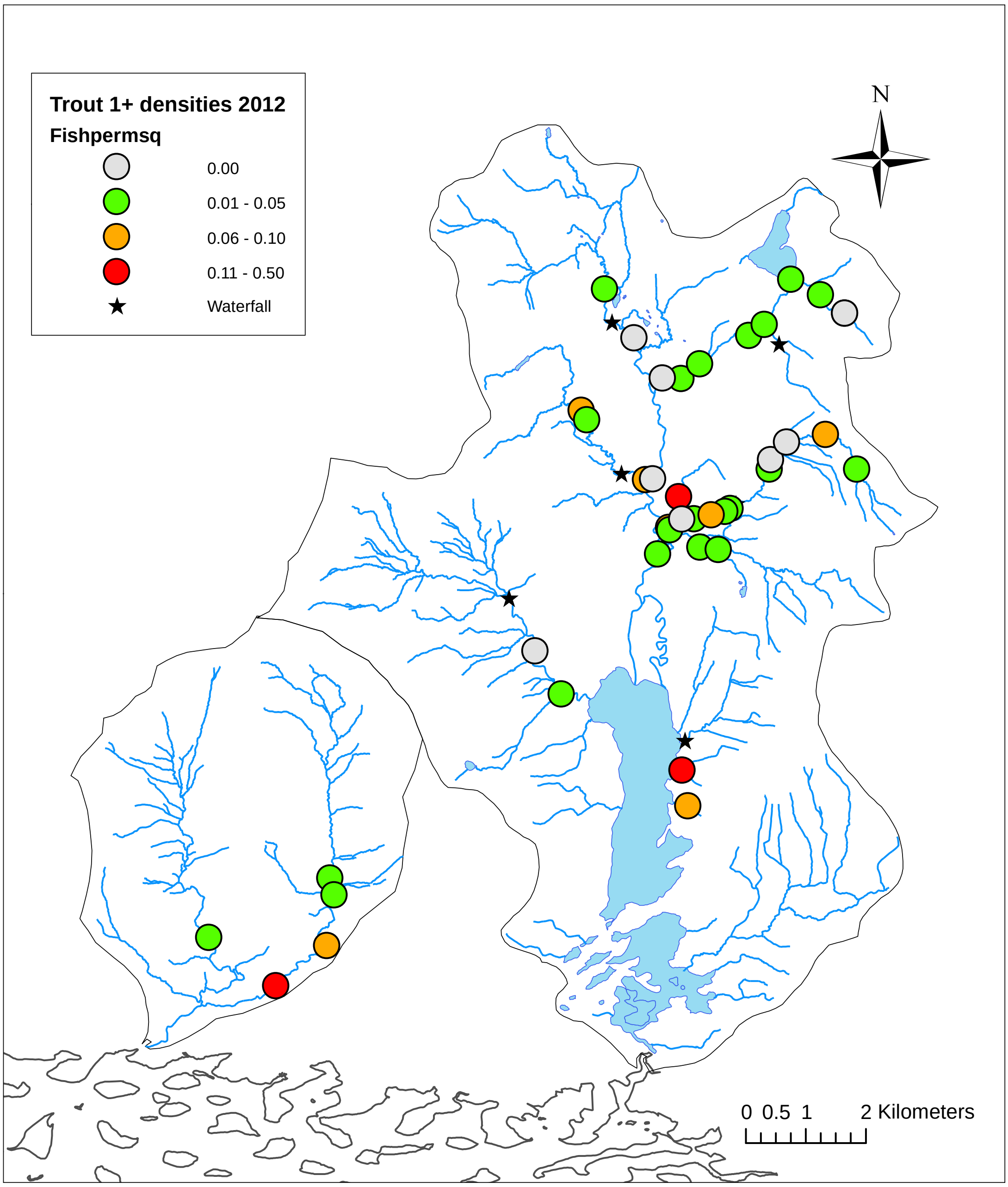

Figure 10-5: Densities of 1+ trout calculated from the 2012 electrofishing survey of the Burrishoole and Owengarve catchments.

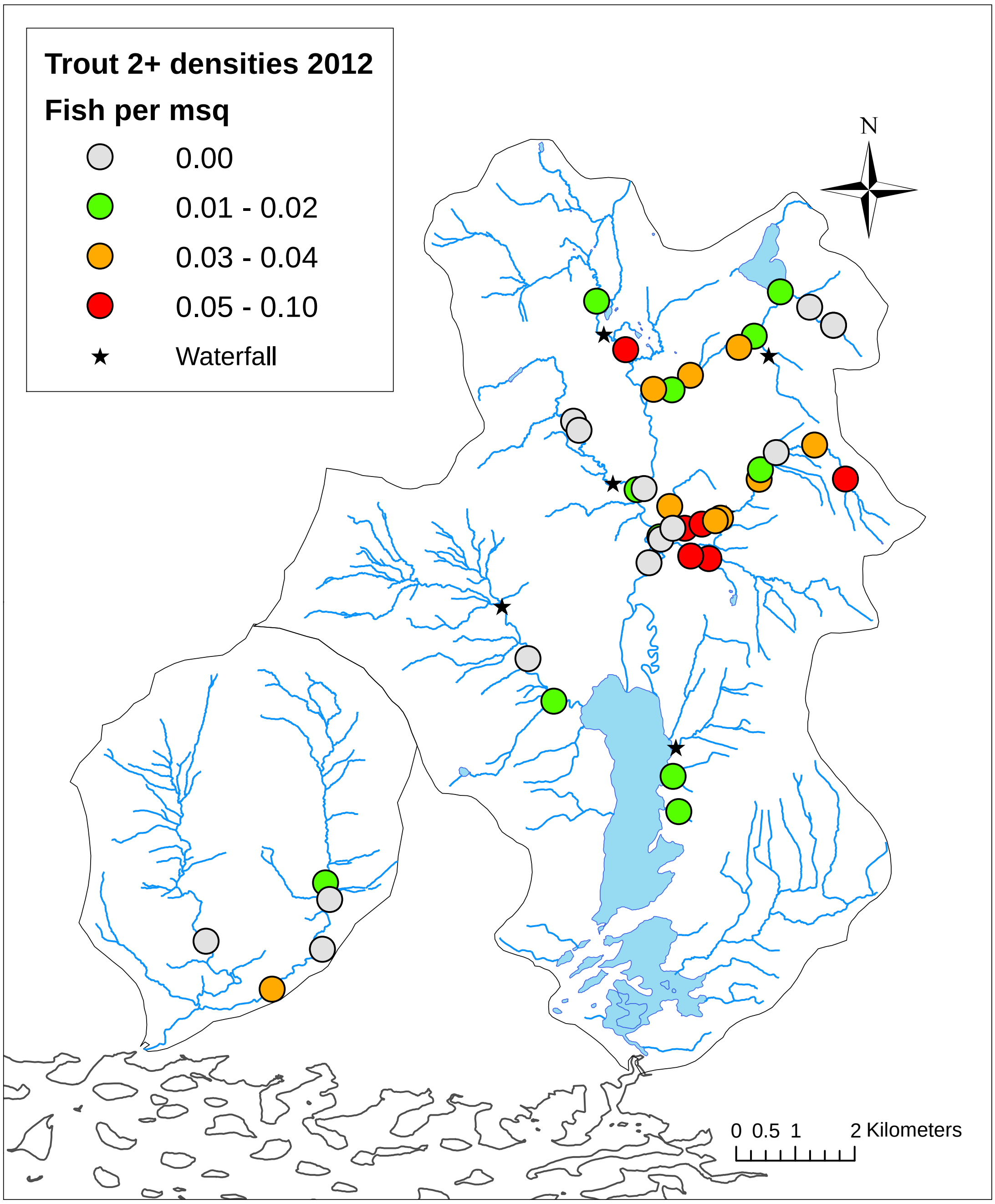

Figure 10-6: Densities of 2+ trout calculated from the 2012 electrofishing survey of the Burrishoole and Owengarve catchments.